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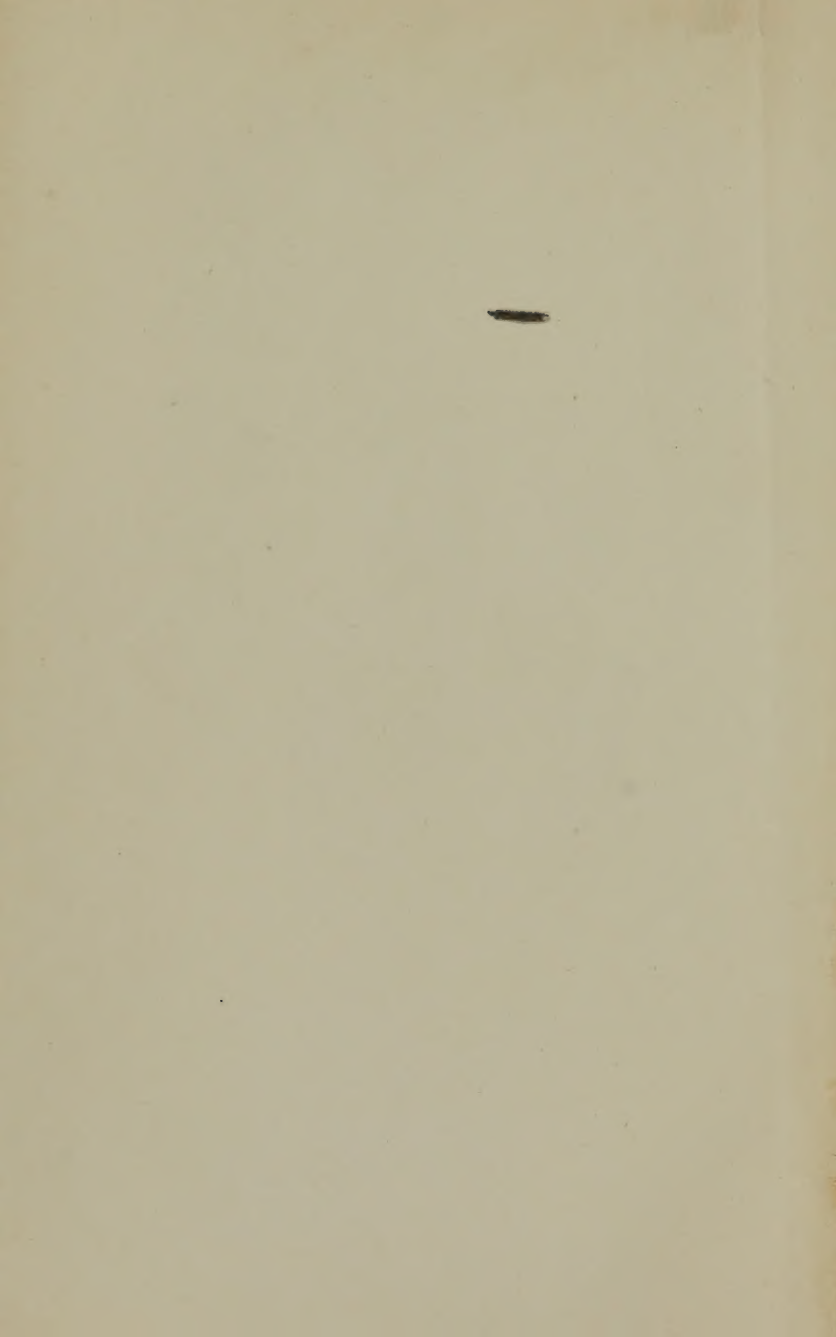


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THE IRRITABLE BLADDER

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THE
IRRITABLE BLADDER,

Its Causes and Treatment :

INCLUDING

A PRACTICAL VIEW OF URINARY PATHOLOGY,
DEPOSITS, AND CALCULI.

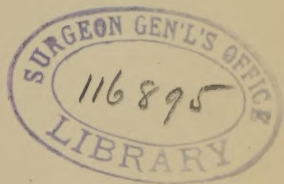
BY

FREDERICK JAMES GANT, F.R.C.S.,

SURGEON TO THE ROYAL FREE HOSPITAL.

THIRD EDITION, REVISED AND ENLARGED,

WITH ADDITIONAL WOOD ENGRAVINGS.



PHILADELPHIA: LINDSAY & BLAKISTON.

1872.

Annex

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1872

PREFACE TO THE THIRD EDITION.

ANOTHER Edition—the third—of this Treatise having been called for, and long before I could find time to supply it, may, I think, be taken as a fair indication of its established acceptance as a guide to a large class of diseases, which are associated by a central symptom—irritability of the urinary bladder. The original design of the work, therefore, remains the same; but the whole has undergone careful revision, with such additional matter, particularly that of urinary calculi, which would seem to render it more complete and practically useful.

As in the previous Edition—the primary object is, with the view to treatment, to trace the various constitutional morbid conditions — of the blood and nervous system, and local diseases of the genito-urinary organs and rectum, which, as internal causes

operating within the body, are severally manifested by a very common and painful affection of the bladder; and, moreover, to connect the constitutional class of such causes with predisposing social conditions of life. This latter aspect of etiology I deem to be so generally important, especially from a preventive point of view, that I have devoted the whole of Section I. to its consideration.

Many local diseases, widely different in themselves, being associated by the functional disturbance—vesical irritability, as a symptom common to them all; their diagnosis or discrimination is, at the same time, incidentally drawn in Section II., which treats exclusively of local internal causes.

In Section III., a special investigation of the *pathology* of constitutional internal causes, as represented by morbid conditions of the blood, leads to a careful diagnostic interpretation of the accompanying morbid conditions of the urine, as discovered by the physical, microscopical, and chemical methods of examination; preceded, in respect to each such condition, by the diseases associated. The various appearances of urinary deposits are also concisely described and depicted, and the various appropriate tests explained, with their application. This is followed

by a similar view of calculi in a condensed form, and their treatment.

This practical view of urinary pathology, deposits, and calculi, will, I trust, still further meet the requirements of all those who, whether as clinical students in the wards of hospitals, or being actively engaged in practice, may find it convenient to have at hand a ready guide on this subject.

The *treatment* of all these conditions, constitutional and local, is taken concurrently with their pathology; that of the former, therefore, as relating to deposits and calculi, being reserved to the last, in order that their treatment might be enlightened, as far as possible, not only by the etiological knowledge of their social origin, but also by the pathology of the blood and urine—as the internal causes in operation, proximately and immediately; in short, by a comprehensive urinary pathology.

I have also noticed the bearing of this knowledge on preventive treatment.

Since the appearance of the former Edition, my experience has been much increased by numerous interesting cases, notes of which I took at the time, or were sent me by the patients. I have, as heretofore, purposely omitted these records; preferring to

imperceptibly express their results in rules and particulars of treatment, rather than further extend the work by introducing the cases themselves.

Lastly, I have to acknowledge my obligations to other authors, most of whom are mentioned in the text; and especially am I indebted to the valuable works by Prout, Bence Jones, Parkes, Lehmann, Julius Vogel, Neubauër, Golding Bird, Owen Rees, Lionel Beale, W. Roberts, and Hassall.

F. J. GANT.

March, 1872.

CONNAUGHT SQUARE.

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THE IRRITABLE BLADDER.



INTRODUCTION.

THE CONSTITUTIONAL CAUSES OF LOCAL DISEASE, AND HOW DISCOVERED.

I NEED scarcely observe that Pathology includes two forms of disease—alterations of structure and alterations of function; both forms of deviation being estimated by comparison with a presumed standard of health. Alterations of structure, and whatever physical properties and chemical constitution may be associated therewith, are together represented by the science of Pathological Anatomy, while Pathology is thus restricted to alterations of function. Such, then, is the general nature of Pathology, and such its more limited and usual signification.

The two forms of disease to which I have alluded are frequently associated, if not inseparably combined. But diseases of structure *precede* their functional manifestations. It may be that the earliest alterations of structure are minute, and therefore likely to escape detection; it

may be that such alterations refer only to the vascular condition of the tissue or organ affected, and that its vestiges are almost or altogether effaced before a *post-mortem* examination ensues, should the disease prove fatal, and thus many nervous diseases may appear purely functional; but instances of functional disturbance *alone* are very doubtful, and are gradually being reclaimed to altered structure. Thus its presence is *more essential* than functional derangement, and the appliances of Pathology in relation to diagnosis relapse into those of Pathological Anatomy. Functional deviations from the standard of health have no significance apart from their accompanying alterations of structure; and common experience reminds us of many instances of sudden death, after which chronic organic lesions have been discovered, the existence of which had never been even suspected during life.

Moreover, alterations of structure are *more constant*, and therefore supply a more certain and exact method of diagnosis. No fixed and invariable relation subsists between function and structure. The *same* modifications of function may accompany very *different* conditions of structure—palpitation of the heart, for instance, being associated with either simple atrophy of that organ, or with the still more fatal lesion of its degeneration into fat; and conversely, the *same* alterations of structure may produce *variable* alterations of function, for the fatty heart may yield no warning palpitation—may throw out no functional symptom—previous to its final

stroke in sudden and unexpected death. Thus, the mere functional symptoms of disease are as the Will o' the Wisp, now present, now receding, and ever eluding our grasp; while the signals thrown out, so to speak, from the interior, by alterations of structure, with their accompanying physical and chemical characters, prove, when perceptible and recognised *during life*, sure and faithful guides.

We may, therefore, conclude that the resources of Pathological Anatomy, applied during life, afford the more early and exact method of detecting and distinguishing diseases—the more valuable method of *diagnosis*.* In what way, then, can our knowledge of their Pathology *directly* conduce to their rational curative treatment? Assuredly by enabling us to estimate the significance and importance of diseases as internal causes, by virtue of their functional *operation*—the *etiological* application of pure Pathology. In like manner, their *continued* operation in their course and tendency, and *prognostic* knowledge accordingly, is determined.

The mode in which *internal* causes operate may be explained by reference to that great law of *balance* between the functions of the various organs and textures of the body, whereby all are mutually associated. If thus the blood's circulation be selected as our starting-point, and as the link adjacent to nutrition, then

* "The Principles of Surgery—Clinical, Medical, and Operative." By the Author.

we may regard respiration, digestion, and excretion as accessory functions, and as having collectively a direct relation to those of the nervous system. These again are in their turn dependent on the former for their support. No link in the chain of this circle can be broken by the Pathological excess, deficiency, or perversion of any one function without disturbing the harmony of all the rest; and although such perturbations must in their turn be referred to certain alterations of healthy structure, and therefore to Pathological Anatomy, yet structural alterations can only *operate* as internal causes by virtue of the functional disturbances which they occasion. Pathology, therefore, suggests the rational curative treatment of disease, by pointing out the functional operation of its internal causes.

The healthy co-operation of digestion, circulation, and other functions, may be appropriately termed their *constitutional* relation.

A due knowledge of functional relations, and of the disturbances of those relations—Pathology—will therefore supplement the resources of Pathological Anatomy in detecting *during life* the *constitutional* causes of local disease. Thus a mere local functional disturbance may prove to be a symptom of disease *in operation* at perchance a remote distance in the body, and which being itself far removed from the scene of its local manifestation, would not *appear* to be the cause of such topical disturbance.

Irritability of the urinary bladder, for instance, representing a more or less painfully urgent desire to frequently relieve the bladder of its contents, is a functional disturbance of this organ, which, arising commonly from some morbid condition of the urine, may prove to be the *local* warning to an individual which first directs his attention to that condition; itself due to a far more grave disease of the kidneys, the stomach, the blood, or the nervous system. Hence the value of many *symptoms*, which, although themselves comparatively insignificant, may nevertheless guide us to discover latent disease in some distant and hitherto unsuspected organ.

If we seek to analyse the operation of constitutional causes, we may perhaps reduce them to the agency of the blood circulating throughout the body, and to the universal distribution of nervous influence, from the central nervous system, to every part. These two agencies are perhaps together the bond of union or sympathy between distant parts, and explain the intimate relation which subsists between their diseased conditions. But whatever theory, or interpretation of facts, we may admit, certain it is that the Pathological relation of distant parts—through the operation of internal and constitutional causes—and therefore the direct applicability of Pathology to the rational cure of disease, cannot be disputed. Vesical irritability, as denoted by painfully urgent and frequent micturition, has been cited in illustration of this position. This dis-

turbance of the function of that organ is at once a symptom of many diseases in distant parts, and the common effect of many constitutional causes.

But there are many *local* internal causes also, as will presently appear.

I would here briefly notice the anatomical condition of the bladder, to which its irritability may be immediately ascribed. The urinary bladder may be regarded as a hollow expansion of mucous membrane continuous with that of the ureters and urethra; the function of this membranous bag being simply to receive and retain the urine until convenience may permit of its discharge. The external aspect of this receptacle is closely surrounded with bands of muscular fibres—the unstriped variety—disposed amid cellular tissue, in figure-of-eight spiral loops, vertically, obliquely, or horizontally.* These muscular bands are plentifully supplied with blood-vessels—the superior and inferior vesical arteries—with also some branches of the uterine arteries in the female—both being divisions of the internal iliac, which inosculate and issue in large plexuses of veins. They are seen chiefly at the neck, sides, and base of the bladder, and terminating in the internal iliac veins, are accompanied in their course by lymphatics. Nerves are moreover

* “Original Dissections,” by J. B. Pettigrew, M.D., Museum Royal College of Surgeons; and, same authority, “On the Muscular Arrangements of the Bladder and Urethra,” &c. Phil. Trans., 1867.

supplied, partly from the sacral plexus, itself derived from the spinal cord, and these nerves are also distributed on the base and neck of the bladder, but a large supply coming from the hypogastric plexus of the great sympathetic is distributed on the upper surface and remaining portion of the bladder, not supplied by the sacral plexus of nerves. The muscular bands, blood-vessels, lymphatics, nerves, and cellular tissue, together form a second layer or coat, superimposed on the "mucous coat" in which the vessels and nerves ramify and terminate; while externally, the "muscular coat" is partially invested by a reflexion of the peritoneum, "peritoneal coat."

The healthy irritability or contractility of the bladder is the vital property of its muscular bands. They contract from time to time, both vertically and transversely, and thus by their joint action expel, as occasion may require, the contents of the bladder. The Pathological condition of increased irritability is denoted by urgent and frequent micturition, and this is to be immediately referred to the muscular or middle coat of the bladder, while the painful desire to evacuate its contents, which is associated therewith, is due to one or other system of nerves, or to both.

This brief anatomical sketch of the bladder elucidates the direct action of certain *local* causes of undue irritability. Thus, the bladder has its *nervous* and *vascular* relations to surrounding organs—as well as to parts

distant in the body. Hence, the operation apparently, of Rectal Diseases; hæmorrhoids, fissure in ano, inflammation of the rectum, stricture—simple or cancerous, abscess about the rectum, and fistula in ano. Also of certain Uterine Diseases; as acute inflammation and cancer.

Should the *capacity* of the bladder peculiar to an individual be diminished from any cause, while the quantity of urine poured into it is undiminished, or, perchance, increased, then a more frequent discharge of urine, or the phenomena of undue irritability, will ensue. The influence of pressure in the neighbourhood of the bladder, whether from constipation, pregnancy, displacements, or benign tumours of the uterus, and the action of other local causes, may perhaps be thus explained.

Again, hypertrophy of the muscular coat will so diminish the capacity of the bladder as to occasion more frequent micturition. Hypertrophy may be produced by any chronic obstruction to the free discharge of urine. Chronic enlargement of the prostate, or stricture of the urethra, will so obstruct the flow of urine, and thereby overwork the propelling power of the muscular coat, as to occasion the hypertrophy or overgrowth of its bands of fibres. The capacity of the bladder is diminished in a corresponding measure, and thus again arises the necessity for more frequent micturition.

Organic diseases, as cancer, affecting the bladder itself, may partly, in like manner, occasion undue irritability of

that organ; but *acute inflammation*—cystitis, being unattended by any notable thickening of the bladder—cannot occasion excessive irritability through any mechanical influence on the evacuation of its contents.

Lastly, there are frequent instances of vesical irritability in which no structural alteration whatever of the bladder can be detected either during life, or after death, but which are associated with certain morbid conditions of the *urine*. This secretion is the natural stimulus to contraction of the bladder, and the retention of more or less urine after micturition, in certain cases of stricture and enlarged prostate, but which are not combined with hypertrophy of the bladder, may explain the co-existence of irritability under such circumstances. The healthy stimulating property of urine may readily be supposed to vary with its chemical composition, and the morbid changes which in this respect it more frequently undergoes, are an excess of either lithates or phosphates, announced by the presence of red or white sand respectively in the urine.* These deposits are due occasionally to some organic disease of the kidneys, but more commonly to disturbance of their healthy excretive function, through the influence of certain constitutional conditions. Thus, the blood may abound in lithic acid, first discovered by

* The chemical composition and microscopic appearance of the Deposits alluded to, and of other morbid states or constituents of the urine, referred to in the course of this work, are described, more particularly, in connexion with their Treatment.

Dr. Garrod in the blood of gouty persons. This gouty condition of the blood is induced by mal-assimilation of azotized food, aided perhaps by some derangement of the digestive process, and the crisis of these constitutional disturbances may be the escape of lithic acid in the urine, accompanied by a painful desire to frequently relieve the bladder.

The following pages will, I trust, tend to elucidate the constitutional and local causes of "the irritable bladder." I need scarcely advocate the direct relation of such an inquiry to the rational prevention and curative treatment of this painful local affection. The removal of a cause necessarily anticipates the recurrence of its effect, and, therefore, by removing the causes in question, their local manifestation will subside. But the true etiology of disease cannot be defined by merely constitutional or local conditions. The evil lies deeper. Thus the indigestion which perhaps precedes the presence of lithic acid in the urine, may itself be preceded by certain errors of diet. This antecedent in the pathological history of irritable bladder carries us beyond its constitutional origin to its primary origin in the infringement of certain conditions which are essential to the preservation of health. These and other hygienic requirements are frequently violated by the *habits* of *Society*, and it is to this aspect of general etiology, as exemplified by irritability of the urinary bladder, that I would now take occasion to invite special attention.

THE SOCIAL ORIGIN OF CONSTITUTIONAL DISEASE, AND
CURATIVE AND PREVENTIVE TREATMENT.

He who succeeds in tracing back an apparently local disease to its constitutional origin in the blood, or other vital structure, contributes to the principles of rational medicine; but he who succeeds in referring the *origin* of such constitutional condition itself to the habits of Society, contributes not merely to the Philosophy of Medicine, and to the cure of disease, but also indirectly, to the preservation of Public Health.

The habits of Society variously influence the hygienic requirements of regimen,—ventilation,—temperature, and clothing,—exercise, daily occupation,—sleep, and the estate of marriage. Our social habits, in these respects, however various, are all concerned in either preserving health or producing disease, and one leading feature in our study of disease should be our search after all those *special* circumstances (including, therefore, habits of society,) by which this or that disease is produced, or its character modified, and by the due consideration of which our remedial treatment should be guided. In this respect, the experienced practitioner surpasses the mere student of systematic works; and viewed in this light, therefore, an inquiry respecting the habits of society as causes of disease, is a legitimate contribution to the principles and practice of medicine. Or again, by

regarding etiology in this more comprehensive sense, the resources of pathology may be applied to reform our social habits—to thereby anticipate their evil results, and aid the preservation of public health. The more prevalent the disease thus investigated, the more valuable will be our contribution to the public good.

It appears to me that this relation of Pathology has hitherto been overlooked. Unhappily, however, he who takes this comprehensive view of etiology, and seeks thus to apply the resources of pathology, is open to misrepresentation. It may be hazardous for such an one to pass beyond the usual confines of medical works, and enter the threshold of social life, without apparently compromising the professional character. Yet I do sincerely believe that the more we regard the constitutional origin of disease as but the reflection of certain social habits, and the more we seek thereby to portray the lights and shadows of their local manifestations, and this in language most descriptive, the more shall we advance “rational” Medicine; and that by coming home to the higher wants of Society, in the *prevention* of disease, the more will medicine, as a Profession, be appreciated and honoured. This view of etiology is that language which everybody will learn, nor disdain to have its alphabet perpetually in their hands. This is that pathology which addresses itself at once to the wants and understandings of mankind: the drama of disease, as personified by the actual conditions of society,

whether present or past—for the history of nations is but a chapter in the physiology and pathology of man.

Such, then, is the *general* nature of that influence which proceeds from our social habits regarded as causes of disease. But of the many excellent works which practical men have hitherto issued, the greater number have been derived from hospital experience of the *poor*, perchance the destitute sick.* Of these records of medicine, some are invaluable class monographs. On the other hand, few such works are interwoven with those social peculiarities which, being incident to the *affluent*, should modify the treatment of diseases, which, if not peculiar in themselves, yet arise under peculiar circumstances, and which modify their character.† There is, perhaps, no disease quite peculiar to any one class of society, but certain varieties and complexions of diseases are respectively induced by habits of poverty, and by those which are incident to ease and affluence.

The habits in question refer either to the regulation of

* See "De Extantiori Frequentiâ et Deterioratione Morborum inter Vulgus." 1788, Toggenburger. "Diseases of Artisans," by C. F. Otto, G. C. Holland, Patissier, Coschwitz, Buniva, Rammazini, Thackrah, and Tralles.

† See "An Essay on the Disorders of People of Fashion," by Tissot, M.D., F.R.S. Translated from the French by Francis Bacon Lee. "Observations on the Influence of Habits and Manners, National and Domestic, upon the Health and Organization of the Human Race, and particularly on the Effect of that Influence as it relates to the present state of English Females in the Higher and Middle Classes of Life." 1822. By Ralph Palin, M.D.

the mind or body; but they may alike issue in one and the same result. The body and mind are indeed such inseparable companions that, as Sterne truly remarks, like a coat and its lining, if you rumple the one you rumple the other.

The first attack on the fortress of health, and the first breach in its bulwarks, come, perhaps, more generally from without. The body is encompassed by many *external* causes of disease. So numerous and varied are these causes, that in one of Addison's admirable essays allusion is made to a fanciful dream written by a Spaniard, in which Death is figuratively represented as a person who metamorphoses himself like another Proteus into innumerable shapes and figures. To represent the fatality of fevers and agues with many other distempers and accidents that destroy the life of man, Death enters first of all in a body of fire, a little after he appears like a man of snow, then rolls about the room like a cannon-ball, then lies on the table like a gilded pill; after this he transforms himself of a sudden into a sword, then dwindles successively to a dagger, to a bodkin, to a crooked pin, to a needle, to a hair.

Of all the shapes which Death from without assumes, clad in the habits of Society, perhaps the most familiar and eventually fatal are errors of diet. Our social habits in this respect are the fruitful parents of many evil results both to mind and body. First and foremost among their immediate effects are the varieties of indigestion, which

may in their turn give rise to certain morbid conditions of the constitution; for example, corpulency and its results frequently to a gouty tendency with lithic acid or lithates in the urine, and irritability of the bladder. Or again, our social habits may induce an opposite state of the general health, but associated with the same vesical irritability. The enfeebling influence of an in-door life, or of only carriage exercise so called, coupled with the want of some daily mental occupation, some object in life, or this, perhaps, supplied by the excitement of "the season," succeeded by ennui and exhaustion, all tend to paralyse the nervous system, and to induce a deposit of phosphates in the urine, with irritability rather than tone of the bladder, in common with atony of the whole muscular system. Under similar circumstances, perhaps, diabetes of various kinds may ensue, with a profuse secretion of morbid urine containing sugar, or an excess of urica, and accompanied by the same incessant and intolerable desire to relieve the bladder. Lastly, not to mention either the habitual neglect of ablution, or the restraints of society, in relation to vesical irritability, we may notice the mismanagement of pregnancy as a frequent cause of that condition; but this glance will be resumed in the sequel. Meanwhile, on thus briefly viewing the various aspects of social life more peculiar to the affluent, we may trace their influence, individually and collectively, in producing one and the same result—this, through the operation of certain constitutional conditions,

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and more especially those of the digestive process, or of the nervous system. Irritability of the bladder is, in fine, one result of many pathological causes, constitutional as well as local. It matters therefore but little from what point of view we commence our survey of social life; but as certain features more prominently invite our attention, I shall, first of all, enter further into detail respecting them.

SECTION I.

CONSTITUTIONAL CAUSES OF IRRITABILITY OF THE BLADDER, AND THEIR SOCIAL ORIGIN.

ERRORS OF DIET, AND MAL-ASSIMILATION OF FOOD.

WE should remember the physiological uses of food. These are, firstly, to supply a material which, when dissolved by the process of digestion, may be absorbed into the blood, and thence repair the waste of the body incurred by exercise; and secondly, to supply a material of such nature, that on being absorbed, shall directly sustain the temperature of the body, by combining with the oxygen of the air introduced by respiration; this calorific process being further aided by combustion of the waste matter referred to. It is obvious, therefore, that wholesome food must not only be digestible or capable of solution, but must also consist of matter the *chemical composition* of which is adapted to repair the various tissues of the body, and to support the animal heat. Such then are the alimentary requirements of all animals, man included; but occa-

sionally the body requires a higher temperature, and therefore demands an additional supply of combustible matter in the shape of fat, starch, sugar, or other carbonaceous substances. This material, if not consumed by the respiratory process, is stored up as fat in the body.

Wholesome food must, therefore, be a due admixture of certain ingredients, and each *natural* variety of food presents a due commixture of these ingredients. They are chiefly albumen, fibrin, gelatine, fatty matters, certain salts, of which common salt is most abundant, and water. I might here notice the proportion of these materials in each article of ordinary diet, in bread, various kinds of meat, vegetables, and so forth; but for such details I would refer to original authorities. It is sufficient for our present purpose to know that the *most* nutritious diet implies a wholesome combination of certain essential ingredients. The nutritive quality of food being thus defined by the *proportion*, no less than the kind, of its constituents, it is obvious that the wholesome proportion of fat to muscle for example, cannot be disturbed, without also, and in a corresponding measure, impairing the nutritive value of meat.

I have elsewhere* pursued this question, and although it may be objected, that I selected for examination

* "Evil Results of Over-feeding Cattle. A New Inquiry." 1858.

certain Prize Cattle, not specially intended for human food, but only as samples of those breeds which most readily fatten, that is, at the earliest age, still it should be remembered that these animals were samples of the ENGLISH SYSTEM of feeding, the *principle* of which has ever been to discover what breeds will most speedily yield the largest amount of fat in the shortest period of time; in order that the capital invested may be returned with interest as soon as possible, and re-applied. The nutritive quality of meat produced is disregarded. The interests of the public are not apparently identical with those of cattle breeders and feeders; and by the pathological results of over-feeding *prize* cattle, the *principle* of the system so generally pursued throughout England was at once convicted and proved to be erroneous. Thus, the over-fattening propensity of this or that prize-endorsed breed may not stop short of disease, while the mere production of fat is certainly not a criterion of the nutritive value of human food.

We may somewhat anticipate the evil results of an injudicious diet. Its primary effects are manifested by the stomach itself, with the surface of which the food first remains in contact. Hence the varieties of indigestion—the irritable, the inflammatory, and the atonic varieties of dyspepsia; the symptoms of which are due to the nerves, blood-vessels, and muscular fibres of the stomach. Thus may we recognise the Irritable Dys-

pepsia associated with pain after food ; nausea, or actual sickness and acidity ; the Inflammatory variety, known by the same local symptoms, coupled, however, with general febrile disturbance ; while Atonic Dyspepsia is distinguished by abdominal distention and flatus, lethargy, and general debility. We may not always succeed in tracing this or that form of dyspepsia to this or that error of diet ; but we may, perhaps, venture to associate the Atonic variety with excess of vegetable food ; while Irritable and Inflammatory Dyspepsia followed by a gouty tendency, lithic acid or lithates in the urine, and irritability of the bladder, are connected with an undue proportion of the more stimulating varieties of animal food.* Nor are the artificial resources of the *cuisine* wanting to aid the stimulating influence of a meat diet. Time, indeed, would fail to enumerate all the mysteries of the culinary art. Their daily results are familiar in our mouths as household words, and their consequences may be seen in the consulting-room of every physician and surgeon. Not that I would censure the judicious use of certain condiments, no less salutary than palatable ; for I well remember the restorative resources of Mons. Soyer on the bleak hill-side of Balaclava, and on the burning shores of the Bosphorus. Such re-

* The further pathological operation of the causes referred to, will be found in Section iii.

sources are not errors, but excellences of diet. The great object of cookery is to render food palatable as well as digestible, or soluble. The former requirement is indeed preparatory to the latter; for the chemical agency of the saliva is now fully admitted, although not fully understood, and the flow of saliva during a repast is very much regulated by the savoury or insipid character of the food. But daily observation convinces me that in this respect and every other, the whole process and purpose of digestion is still misunderstood or disregarded by the public at large. The stomach still inflicts its pains and penalties, and with all our sanitary pretensions, there is not a more prolific cause of disease in daily operation than errors of diet.

The food requirements of every individual are regulated by age, sex, and temperament, and by other circumstances of distinction.

In early life, when the body is growing, the demand for food is proportionably greater than at maturity, or than in advanced life, when nutrition fails and the body dwindles, or perchance accumulates fat, instead of the growth and development of its muscles and vital organs; but while these are forming, the *quality*, no less than the quantity of the food, should be specially adapted to the kind of tissues which are then growing *most* rapidly. The chemical components of the nervous system—of the bones and muscles—should respectively be found in the food. How faithfully are the aliment-

ary requirements of young animals supplied by milk, the first and best provision of bountiful Nature for her offspring! It is not during this period of life that irritability of the bladder arises from an over-azotized and stimulating diet.

The *regular* supply of food is also very important—not to disappoint the periodic demand of the stomach, and to meet the perpetual waste of the system. To this end the appetite, if not vitiated by excess, is a sure and faithful guide. The digestion and assimilation of food is not in the ratio of the amount taken into the stomach, but in proportion to the wants of the system; and any surplus food, if not speedily evacuated, is absorbed, accumulates, and encumbers. The high-pressure circulation of blood which ensues, may break down at any moment, and eventually must yield. Over-eating and drinking are indeed drafts on the constitution, although payable perhaps some years after date.

But the modifying influence of other individual conditions should not be overlooked in our estimate of diet. In *females*, the process of nutrition is perhaps comparatively more speedy than in that of the male sex; and during pregnancy certainly, the growth of the foetus demands an additional supply of food over and above the ordinary requirements of the system. The nourishment during so many months of the forthcoming offspring is equivalent to the loss of so much blood by

the mother, and this loss should, therefore, be replenished by a more generous diet during the whole period of pregnancy. It is well known that the neglect of this precaution favours the occurrence of anæmic convulsions after parturition; and it is no less certain that puerperal mania may ensue as the result of exhaustion from over-suckling. I would only add, that in such cases it must be obvious, that all reducing measures will only increase the general excitement; and although the happy and triumphant hopefulness of approaching mania might seem to forbid all stimulants, yet that the excitement, seldom fatal, will subside under the free administration of wine and of a nutritious diet.

The food-requirements of both age and sex vary also with the *individual temperament* or constitution. Temperament implies an excess or deficiency of some one function, or of certain functions, in relation to others. Thus, the sanguine or red-blood-making constitution, with its tendency to surfeit, can be maintained in high health on less animal food than the phlegmatic, languid, pale, lymphatic person, from whom a large portion of the food passes away undigested or unassimilated. Again, the bilious, or bile-forming and fat, require less of that material than the nervous and often attenuated, whose restless and sleepless disposition forbids obesity.

The quality of the food consumed by an individual should be regulated, no less than its quantity, by the

activity of respiration. This again is affected by temperature, and therefore by climate and period of the year. Compare the dense air and rapid breathing experienced on a cold day, or in northern latitudes, with the hot, light, vapid atmosphere and suffocating sighs as we approach the tropics. The respiration rises and falls inversely as the temperature, and an instinctive feeling suggests either the use or avoidance of fat, sugar, alcohol, and other substances which are readily consumed when the respiration is active, but which accumulate in the body as fat when that function is languid. The Highlander who breathes freely the cold mountain air, may drink draughts of raw whiskey with impunity, but who does not sympathize with Lord Ogleby's disgust for "hot rolls and butter in July?"

By a due supply of air, and by an active respiration, fat and fat-forming substances are consumed, being converted into carbonic acid and water, which pass off as the breath, and by this process of combustion the warmth of the body is maintained. Should the respiratory process be *over-active*, then not only will the fat of the body be consumed, but the azotized textures, such as the muscles, are invaded, their carbonaceous portion is burnt off, so to speak, and the remainder appearing as an excess of lithates in the urine, may occasion irritability of the bladder. On the other hand, if the respiratory function be inactive, the warmth of the body speedily

subsides ; and should the *clothing* be insufficient, then more warmth, more respiratory combustion, is needed, and thus, more fat in the food as fuel. The outcast may, therefore, be literally “starved with cold.”

If, however, the supply of fat food should be somewhat guided by temperature and clothing, much more should it be regulated by *exercise and sedentary habits*. Active exercise quickens the respiratory process, oxygenates the blood, and thus consumes the fat, and fatty matters. Sedentary habits favour their accumulation, and the supply of fat should therefore vary with its expenditure. Exercise further implies the waste of the muscles, and indeed of every portion of the body, and this waste must be repaired by a due proportion of the azotized constituents of food. Repose, on the other hand, arrests the wear and tear of the textures, and therefore the demand for azotized food, which now accumulates in the blood. Hence follows gout, or perhaps rheumatism, with irritability of the bladder. But—as it has been truly said—while “gout is the punishment, some have thought it the privilege, of the rich, of persons who live fully, luxuriously, and indolently, rheumatism is most frequently the appanage of the poor, and of those who toil.”

Daily occupation must be regarded as something more than exercise, and as implying the wear and tear of the nervous system. The materials for its repair should, therefore, be found in the food. Phosphates in the urine

are partly the *débris* of the nervous system, and the late Dr. Golding Bird mentions the case of a well-known clergyman, who led a comparatively inactive life during the week, but who undertook the arduous duty of three services every Sunday. "This gentleman was a tall thin person, of dark complexion, lustrous eyes, and almost phthisical aspect. He was the subject of constant dyspepsia. The urine passed on Saturday evening, as well as on Sunday morning, although repeatedly examined, was healthy except in depositing urates, and being of high specific gravity. Before his Sunday duties were completed, he almost invariably experienced extreme fatigue, and a painful aching sensation across the loins, in addition to the flatulence and epigastric uneasiness under which he constantly laboured. The urine voided before retiring to rest after the severe exertions of the day, was almost constantly of a deep amber hue, high specific gravity, and deposited the triple phosphates in abundance. The urine of Monday would contain less of this salt, which generally disappeared on the following day, and once more reappeared on the following Sunday evening. I had an opportunity of observing this state of things for several weeks, and it ultimately disappeared on the patient relaxing from his duties, and enjoying the amusement of travelling for a few weeks." Another gentleman "had suffered sad reverses—his irritability was most distressing, and rendered more intolerable by the severe efforts he made to restrain it."

Lastly. *Sleep* implies the temporary reduction of every destructive change, thus facilitating the perfect repair of the entire mechanism, and the readjustment of every function.

“Sleep, that knits up the ravell’d sleeve of care,
The death of each day’s life, sore labour’s bath,
Balm of hurt minds, great nature’s second course,
Chief nourisher in life’s feast.”

The relation of sleep to food is here clearly set forth by the poet of nature. Those who sleep much, get fat, and, therefore, require less of that kind of food, and less meat also, and other azotized matters. Those who rise up early and are late to rest, and who eat the bread of carefulness and anxiety, require a more generous and nutritious diet. Nor can we doubt that habitual deprivation of sleep, whether from mental disquietude or as the result of late hours and dissipation, very much conduces to that enfeebled state of the nervous system with which is often associated phosphatic urine and irritability of the bladder. In such a case the rational treatment is—rest.

HABITUAL NEGLECT OF ABLUTION, AND MAL-EXCRETION.

I have hitherto considered those constitutional causes of the irritable bladder which operate by *adding* something noxious to the blood, and which appears as an excretion in the urine, in the form of certain deposits, or of urea,

sugar, and so forth. I now proceed to notice the *retention* of certain excrementitious matters in the blood, or of the urine itself in the bladder, and this by the habitual neglect of certain very obvious sanitary requirements. The duty of the skin is supplementary to that of the kidneys in discharging from the blood the waste of the muscles and other textures. The function of the kidneys in this respect, no one can fail to disregard; for by the provision of an all-wise Providence, our instinctive feelings dictate the occasional necessity of relieving the bladder, and the temporary suspension of that necessity for even a few hours beyond the usual period would soon alarm. Not so with the skin: every one talks of the *pores* of the skin, but many overlook that *insensible* perspiration which silently, yet unceasingly, bedews the whole surface of the body. The skin is always filtering away poisonous matters from the blood. And the pores should, therefore, ever be kept open.

I have known symptoms of poisoning ensue from the *habitual neglect of ablution*, especially of those parts, such as the feet and arm-pits, where the nature of the perspiration would seem to instinctively suggest its speedy removal. Yet, what says common experience? that day after day, weeks, months—ay years, may pass away, and even among the educated classes of society, with nothing more than dry-rubbing. Every bed-room should have a bath, and its use should be a matter of education. By neglecting this precaution, the pores

become stopped up, and the poisonous excrement is partially retained in the blood. The same pernicious consequences then ensue as from over-eating animal food. The kidneys are over-worked in their endeavour to relieve the system; the urine becomes highly acid—perhaps deposits lithates, and irritability of the bladder is induced.

The value of bathing should, however, be estimated not merely by its efficacy in purifying the blood of certain poisonous matters, but also as a method of gratefully stimulating the nervous system, and of bracing and invigorating the circulation. In sad contrast with this healthful condition is that peculiar feebleness which ensues from a phase of our social existence to which I would next invite attention.

IN-DOOR LIFE AND CONSTITUTIONAL IRRITATION—SOFA-LIFE—CLOSE ROOMS—INDOLENCE AND MENTAL ENERVATION, WITH SUPPRESSION OF THE NERVOUS FORCE AND IRRITABILITY—HYSTERIA AND ITS CONSEQUENCES—MENTAL MALADIES AND THEIR INFLUENCE.

On whatever variety of constitutional disease we turn the mirror of daily life, we see reflected the habits of society; but there is perhaps no morbid condition of the system which reflects so clearly certain phases of

social life as Constitutional Irritation. The late distinguished Mr. Travers thus defines Irritability: "Every part of a living animal has its peculiar function, to the performance of which it is incited by an appropriate stimulus. Its susceptibility of the impression of such stimulus is denominated its Irritability. This property is not confined to any particular form of organization, as nerve, muscle, or blood-vessel; it exists in every organ, simple and compound." Irritability, therefore, expresses *susceptibility*, but is not aught distinct from the several functions themselves of the various organs which together form the living body. The transition from healthy to morbid irritability is obvious. "Every organ has its peculiar mode of irritability. So long as it neither exceeds nor falls short of its due proportion, the *harmony* of the system, resulting from that of its constituent organs, is strictly preserved. But by a variety of causes, both internal and external, it is subject to be so augmented, diminished, or perverted, as to constitute a material deviation from health, or an actual morbid condition."* Thus, I may add, the equilibrium of the functions is overbalanced, and the harmony of the system is disturbed; in fact, *Constitutional* Irritation ensues; and the urinary bladder may be one organ whose functional activity preponderates.

* "An Inquiry into that Disturbed State of the Functions, usually denominated Constitutional Irritation."

But the property of irritability is sometimes regarded as belonging more peculiarly to the muscular system, and to those parts, such as the bladder, which contain muscular fibres. "When a muscle, or a tissue containing muscular fibres, is exposed in an animal during life, or soon after death, and scratched with the point of a knife, it contracts or shortens itself, and the property of thus visibly contracting on the application of a stimulus is named 'vital contractility,' or 'irritability,' in the *restricted* sense of this latter term."* This contractile power may exhibit itself in either of two ways: by its strength or force, or by the rapidity and repeated occurrence of contraction; and the latter two-fold manifestation is perhaps more especially implied by the term muscular irritability. The strength or force of muscular contraction, coupled with its long duration, is spoken of as its *tone*, and this phase of irritability is manifested by muscles in an inverse proportion to the rapidity of their contraction. A strong muscle contracts slowly, and endures; a weak muscle rapidly, repeatedly perchance, but ineffectually. When, therefore, the muscles become flabby and weak from *insufficient exercise*, any tissue or organ which contains muscular fibres may then be over-ready to contract, or be over-irritable; and thus irritability of the urinary bladder may be one result of general debility. In this

* "Elements of Anatomy," edited by Professors Sharpey and Quain.

way the enfeebling influence of a *sofa-life*, so frequently indulged in by hysterical persons, with also the recumbent position for presumed spinal disease, may favour that excessive irritability of the bladder which is frequently experienced under such circumstances. This remark is quite compatible with, and indeed corroborated by, the observation of a well-known writer, who notices the common association of hysteria with muscular debility from over-exercise,* an error which, no less than the habitual indulgence of repose, conduces to hysteria.

In fact, whatever occasions loss of strength, indirectly elicits an unduly susceptible, or weak and irritable state of the whole muscular system, including muscular organs such as the urinary bladder. Hence the trembling agitation—the rapid breathlessness—the palpitating heart—the frequent diarrhoea, and undue irritability of the bladder, which severally distress the feeble and often nervous victims of an *in-door* life. Think of the factory girls of England!

Nor can we overlook the influence of *hot and close rooms*, such as are habitually experienced in private life, during “the season,” and at operas, theatres, and nearly all other places of public resort. The hot and over-breathed air of such places impairs the strength and promotes irritability, and this by a twofold mode

* “Spinal Irritation.” By Thomas Inman, M.D.

of operation. The blood of anyone who is already half-suffocated cannot be oxygenated, and his strength renewed, by draughts drawn from an atmosphere which is itself, in great measure, the breath of others. But the heat of a close and over-breathed atmosphere is also prejudicial by directly exciting the circulation of blood, thus promoting the rapid and ill-regulated secretion of urine, which stimulates the bladder to repeatedly relieve itself of its contents. I mention this one result of a heated atmosphere as being an illustration of irritability consistent with the design of this work; but the breathlessness and palpitation which accompany general debility are aggravated by the exhaustion experienced in over-heated, no less than in confined, apartments. We could readily adduce many illustrations of this view; but it would be idle to enumerate the results of common experience.

I pass on to another aspect of in-door life, and one which prevails much among those who suffer from hysteria; and as the pathology of this morbid condition of the nervous system may, I think, be elucidated by reference to the social circumstances amid which it more commonly arises, I would first trace the results of *indolence and mental enervation, with suppression of the nervous force*. We should remember that health implies not only the *due balance* of the various functions taken *collectively*: of the digestion of food—the circulation of blood—the respiration of pure air—the excretion of

noxious matters from the blood, as the urine, perspiration, *et cetera*, and the influence of the nervous system; but implies also, that which is not sufficiently noticed in books, the harmony of the several *elements of each* function. For example, the process of digestion implies the co-operation of a certain supply of blood to the stomach and intestinal canal, with a certain muscular propulsion of the food through the stomach onwards, and, lastly, that both of these requirements should be regulated somewhat by the influence of the nervous system. If, therefore, one or other of these elements be deficient, or excessive, the process of digestion is interrupted in a corresponding degree, and hence the varieties of indigestion as already explained. Analogous elements are associated in each of the other compound functions, and the suppression or predominance of *any one element*, presents analogous varieties of functional disturbance. Thus the functions of the brain and spinal cord, taken as a whole, imply the harmony of the *mental faculties*, intellectual and moral, coupled with *sensation and volition*; and, further, that these endowments should co-operate with those *involuntary* motions which are chiefly due to the agency of the spinal cord. These endowments of the central nervous system are duly balanced in health. Each, however, is liable to be unduly excited or depressed; and I need only enumerate the well-known morbid conditions of insanity, excessive and defective sensibility, paralysis, convulsive movements, *et cetera*.

Further, the functional elements in question obey this remarkable pathological law; that if the phenomena which should be manifested by the brain are *temporarily suspended*, then those of the spinal cord are unduly excited. Hence the characters of Epilepsy when fully developed—namely, suspension of consciousness, coupled with convulsive movements of the limbs and trunk. The operation of this pathological law, illustrated by Epilepsy, has, I think, hitherto been overlooked. It points to—I do not say proves—a new physiological principle, which I would term the *Unity of the Nervous Force*. By virtue of this principle—the temporary suspension of that force in one portion of the central nervous system is necessarily accompanied by its undue display in another direction; and its excitement in one portion is as necessarily followed by its exhaustion in the remaining portion of the system.

The application of this law would, I think, sufficiently explain the immediate nature of other nervous diseases, which I may take another opportunity of alluding to; and, moreover, guided by the same law, we may detect the evil influence of certain habits of society in producing that morbid condition known as “nervous excitement.”

It may be that the social condition of an individual exempts him or her from the necessity of any daily occupation. The intellectual faculties, not being roused by the stimulus of any professional avocation or the

pursuit of trade, are prone to inactivity. The nervous force must, therefore, find some other outlet. Under such circumstances, the *emotional* faculties are apt to predominate. Hence the origin, or at least one source, of that peculiar morbid susceptibility, the sensitiveness of those who are "all feeling,"—hence that restless apprehension of some impending evil, the very offspring of luxury and ease—hence that suicidal melancholy, "which rejoiceth exceedingly and is glad when it can find the grave." It was thus that the fortitude of our great Lord Clive gave way: not when starved down during fifty days at the siege of Arcot; nor when, by day and night, marching against Bengal, with the eager announcement of his coming, "Tell Meer Jaffier to fear nothing; I will join him with five thousand men who never turned their backs:" not in that critical hour of self-reliance, did Clive's dauntless spirit falter, for there is, I believe, a period in the life of "every man of work," when his whole intellectual powers are aroused, and in their turbulent activity the nervous energy of India's conqueror found vent; but, in the quiet evening of life, when the revulsion of that energy ensued, then reappeared the spectral melancholy of his early days—

"He heard a voice we do not hear, which said he must not stay;
He saw a hand we do not see, which beckon'd him away."

If, however, through intellectual lethargy, the emotional faculties are thus unduly developed, then another

phase of the nervous force may present itself in certain individuals. Their general *tactile* sensibility may be exalted, even to pain. An original writer truly observes, "Such persons are commonly called nervous. They are worried with trifles, startled at shadows, distracted by noise or bustle, never free from some ache or pain, almost every feeling is suffering; what in others would be slight pain, in them amounts to agony. Hence they are perpetual invalids, quite unfit for the rugged path of life, over which they walk, as it were, barefooted and thin-skinned."* I remember to have read somewhere a very graphic description of such an individual—

"In every age and country there lives a man of pain,
Whose nerves like chords of lightning shoot fire into his brain;
To him a word's a sting—a look or sneer a blow,
And more in one short hour he feels, than some in ages know."

The physiological truthfulness of the sentiment certainly surpasses the poetry of these lines.

This fiery condition of the nervous system is more frequently experienced in certain parts of the body. Of these I may mention that piercing kind of headache known as *clavus hystericus*; spinal and abdominal tenderness; pain in the breasts and joints; and other varieties of local nervous affections. Read the testimony of a high authority, as to their social origin.

* "Principles of Medicine," "Excessive Sensibility." C. J. B. Williams.

“I do not hesitate to declare that among the higher classes of society, at least four-fifths of the female patients who are commonly supposed to labour under diseases of the joints, labour under hysteria, and nothing else.” “This liability to hysteria is, in fact, among females one of the several penalties of high civilization. It is among those who enjoy what are supposed to be the advantages of affluence and an easy life that we are to look for cases of this description; not among those who, fulfilling the edict of the Deity, ‘eat their bread in the sweat of their face.’ ”*

Again, one or more of these local manifestations of undue sensibility may be associated with some perversion of one or other of the special senses. The taste may prefer wormwood to honey, and chalk rather than cheese, the eye may be intolerant of light, every smell may be a stench, and every sound a discord. To these depraved sensations may be added certain functional derangements of the internal organs, proceeding from excitement of either the great sympathetic or spinal nervous systems. Through either channel the nervous force may, as it were, find vent. Thus may we explain that distressing sensation of choking and constriction of the throat, globus hystericus, with hoarseness, perhaps loss of voice, which

* “Local Nervous Affections.” Sir B. C. Brodie, Bart.

arises under "nervous excitement;" the diarrhoea, and perchance vomiting, which may ensue under similar circumstances; the occasional hiccough, dry loud cough, breathless agitation, palpitation, and *irritability of the bladder*, which are apt to supervene. Lastly, these phases of nervous excitement may occasionally terminate in a sudden and violent paroxysm, or fit, of *involuntary* movements, and which indicate a further expenditure of nervous force derived from the central reservoir.

Such, then, are certain functional disturbances of the nervous system, which, taken collectively, have received the inappropriate name of HYSTERIA—a word which, from its etymological meaning, would imply some disease of the uterus; yet I would rather define it to be a disturbed balance of the nervous force, whereby its temporary suppression in one direction determines its undue preponderance in other parts of the body. These local manifestations of the nervous force are not peculiar to either sex, but are occasionally witnessed in males, as the experience of every medical observer, and indeed common experience, will testify.

Guided by that view of the pathology of hysteria which I have endeavoured to establish, we may, I think, readily explain the more frequent occurrence of this disease in the female. The independent dissections of Dr. Robert Lee and of Dr. Snow Beck

demonstrate that the uterus is abundantly supplied with nerves, by virtue of which this organ is so intimately related to the entire nervous system, as to respond most promptly to its prevailing condition, whatever that may be. We are, therefore, prepared to recognise in the "uterine excitement" of hysteria a mere discharge of superfluous nervous energy, an excitement, only in proportion to those large plexuses of nerves with which the uterus is so plentifully supplied. The nervous excitement of hysteria does not emanate from the uterus, for in many instances the function of menstruation is only *secondarily* impaired; while in other cases that function is fulfilled regularly and sufficiently, and the organ itself presents no organic disease or displacement. In a series of cases recently published by Dr. Robert Lee may be found such as the following:—

"Married, barren, age 26.—Hysteria in early life: in good general health until her marriage six years ago. Catamenia regular. Now suffering from hysteria in a violent degree—no disease of the uterus."

2. "Single, only 19.—Had been suffering for some time from hysteria and almost total inability to walk; recently went to Scotland, when she was rendered insensible by chloroform, and an unsuccessful attempt made to introduce a speculum or some metallic instrument into the vagina. Suffered violently after this attempt. Present state—hymen lacerated, vagina

contracted, os and cervix uteri in the most healthy condition, and not displaced.—Suffering severely from hysteria.”

3. “Single, age 20.—Always hysterical; was about to be married contrary to her inclination, and was in the country during the summer in her usual health, when a practitioner, looking stedfastly at her, said, ‘I am sure there is something wrong with your womb.’ Being alarmed, she permitted him to examine her with the speculum, and received the information that the mouth of the womb was ulcerated. She was five weeks under his care, during which time she was cauterized almost daily. On leaving the watering-place where this occurred, she was recommended to place herself immediately under the care of Dr. ———. She has been speculumized again, but the ordinary medical attendant stepped in and stopped the cauterizing. Gushes of water are now said to take place from the uterus.* Os healthy and closed.”

4. “Married, barren, age under 30.—Hysterical fourteen years, and ill during the whole of that time from supposed inflammation of the bladder.† Scalding in passing urine, and great aching before and after, throbbing in the epigastrium; catamenia regular, but very profuse. During nine years has been under the care of a London physician for ‘inflammation and ulceration of the womb.’ Leeches applied many times. ‘I cannot

* Or from the irritable bladder?—F. J. G.

† Or irritability of the bladder?—F. J. G.

tell,' says she, 'the number of times the speculum has been used and the caustic.' No displacement or organic disease of the uterus detected."

5. "Married, age 36. Previous history.—Some accident during her first labour. In the interval of three years between the birth of her second and third children, was under the care of two physicians in London, who employed the speculum and caustic frequently during many months. Three hundred leeches were also used externally, by which her strength was greatly reduced; gradually was restored to health, but relapsed, and 'again went through the same mode of treatment at intervals.' Last delivery took place six years ago; since then has been suffering 'from violent sickness and spasm, hysteria, palpitation of the heart, exhaustion,' and inability to walk. Mercurial suppositories twice weekly; croton oil rubbed externally. Present state—in a state of great debility; swelling of feet and ankles, palpitation of heart, profuse leucorrhœa, unfit for any duty in life; no disease of uterus detected. The health of the patient was in time completely restored by rational *constitutional* treatment."

6. "Single, age 23. Previous history.—Ill during six years, owing, it was supposed, to riding on horse-back. Catamenia regular, but painful—*frequent desire to relieve the bladder*; fits of hysteria; constant headache, 'sense of pressure on the top of the brain.' Examined with speculum, and caustic frequently applied; violent uterine excitement followed, and immoral habits, which

rendered her miserable. Present state — no organic uterine disease.”

These cases speak for themselves.

The remedial treatment of a constitutional disease so protean as hysteria must necessarily vary with the circumstances under which it arises. If my theory of the unity of the nervous force be correct, and that the *undue local* manifestations of that force, whether as uterine excitement, nervous palpitation of the heart, or other varieties of nervous functional disturbance, are grouped together under the inapt and inexpressive term, hysteria; then, I say, the rational remedial treatment of that disease is fulfilled by our endeavour to restore the *balance* of the nervous force, through searching out those habits which, frequently arising from the social condition of the individual, operate as causes of hysteria. The moral and intellectual condition of an individual in relation to the general course of his, or her, daily life, cannot be regulated by medicine.

No *medicinal* treatment can reform the ill-regulated habits which are apt to induce the hysterical diathesis. Its evil origin lies deeper in the depths of a vicious social education, and in that listless apathy and mental fallowness which are engendered by the want of some definite pursuit, some object in life.

The revulsion and reaction—or nervous excitement of hysteria—is frequently associated with general de-

bility and muscular irritability, especially of the urinary bladder; and under these circumstances, I have repeatedly observed the beneficial operation of the compound spirit of sulphuric ether and of other anti-spasmodics having an allied chemical composition, which I have prescribed with bark. In the case of a married woman under my care, in the hospital, an uncontrollable desire to micturate occurred every few minutes; but this vesical irritability subsided under the above treatment, and when she left the hospital, she could retain her urine for the average period. I believe the class of anti-spasmodics to which sulphuric ether belongs to be more useful in subduing hysterical irritability of the bladder, than any other of the anti-spasmodics. At the same time we should not overlook the advantage to be derived sometimes from preparations of valerian and assafoetida; the latter especially, when used as an enema; or again, sometimes the nitrate of silver, sometimes the sulphate of zinc, sometimes the preparations of iron or copper, prove useful.

Sea-bathing is not unfrequently very efficacious; but certain precautions in the use of this remedy should be observed.

It is necessary to keep in view the purpose of bathing, whether in salt or fresh water. Unquestionably, one intention, that of cleanliness, cannot be overlooked; but immersion produces further results.

These results are effected by various circumstances. Firstly, the temperature of the water. The warm bath directly stimulates the skin and excites the circulation; yet this effect too frequently issues in exhaustion, and, therefore, is not generally conducive to health. The tepid, or rather, the cold bath, may also produce exhaustion, but more generally its influence is refreshing and invigorating. These beneficial results are preceded by temporary pallidity or blueness of the skin, now bloodless and shrivelled. The heart, if healthy, soon beats with renewed vigour, and speedily restores the balance of the blood's circulation, thus producing a general glow, refreshing the strength and exhilarating the spirits. Or again, should the heart labour in vain to restore the general circulation, then a sensation of chilliness supervenes, with prostration of strength, dejection of spirits, and headache; while, in addition to these symptoms of a congested brain, bordering on apoplexy, other internal organs also give proof of their being overloaded with blood, and hence the oppressed breathing, perchance the diarrhoea, and other symptoms of a sluggish circulation. These evil results of cold bathing, no less than its beneficial effects, are alike modified by individual peculiarities of *temperament*, *by age*, *sex*, and other circumstances compatible with health; but such peculiarities are all referable to individual powers of reaction after exposure to cold.

The experience of each individual is, therefore, the best guide to bathing; at the same time certain general directions should be observed.

Cold bathing should not be indulged in when a sensation of chilliness is felt, but rather when the *surface is warmer than usual*, and this condition should be promoted by previous exercise if necessary. On the other hand, the *exhaustion of recent fatigue, not yet repaired by adequate sleep*, is also a condition unfavourable to healthy reaction. Well do I remember the old posting days, when a journey to Hastings or St. Leonards was indeed a tedious undertaking; and I also remember the depressing effect of that “dip the first thing in the morning” after our late arrival over-night.

Again, *the evil effects of bathing on a full stomach* are known to every one, but the debility occasioned by *prolonged fasting* is, equally with fatigue, unfavourable to healthy reaction. This circumstance is generally overlooked by families in their arrangements at the sea-side. The habit of dining, say at 4 p.m., in order to enjoy a drive or walk in the cool of the evening, occasions too long an interval of fasting until the following morning—the period of the day usually selected for bathing. Under these circumstances, when bathing is indulged in before breakfast, I have known the usual headache, lassitude, and chilliness, prevented by a crust of bread and cup of milk.

So much for one or two general directions concerning

the influence of bodily condition, on healthy reaction after bathing. I would now direct attention to *those circumstances which affect the temperature of the sea*, and thus relate to the same desirable result. I need scarcely notice the *period of the year* in respect to sea-bathing, for it is only during a certain period that such bathing is prevalent. During the months of July and August the average temperature of the sea varies from 60 to 70 degrees Fahrenheit, but that temperature must also vary with the *period of the day*, and is, moreover, influenced by the *ebb and flow of the tide*. At high water, say 3 or 4 P.M., the temperature of the sea is from 10 to 12 degrees Fahrenheit above that at low water, say 8 p.m. This difference of temperature is due to the sun—in fine weather—having heated the sand at low water, which gives out its heat during the returning flow of the tide. Those who are susceptible of taking cold should, therefore, not select an undercliff situation unless exposed to the early sun. Moreover, they should choose a sandy shore, and wait until that period of the day when the returning tide has been long heated by the sun, and warmed also by the surface of heated sand. With these precautions, those who have hitherto suffered from headache and lassitude after ordinary bathing, may enjoy an almost tepid bath. This convenience, resulting from situation, may be found at Hastings and St. Leonards, Eastbourne, Brighton, Ramsgate, Margate, and other watering-places along our southern coast.

The foregoing remarks respecting the temperature of the sea, apply only to fine weather; for when the sun is overclouded and the sea rough, then the conditions to which I have alluded will necessarily be disturbed. This leads me to observe that *the direction of the wind* also influences the temperature of the sea. A cold east or north-east wind will not only so mingle the water as to reduce its general temperature, but will also, as it were, fan its surface cool. I need scarcely add that the bather during a fresh breeze should be as much as possible under water, and not exposed to the cooling action of evaporation.

The most healthful *period for remaining in the water* is also important. I have read somewhere of certain experiments which were made to determine this question. By placing a thermometer in the mouth it was ascertained that the greatest loss of heat ensued in about two minutes after immersion. This would seem to be about the period when reaction commences, and that the temperature of the body rises gradually until the expiration of from ten to twelve minutes, although it may then be lower than before immersion. I would not, however, limit the period of immersion to two minutes, but would suggest the propriety of entering the water only *once*, and of not reducing the temperature of the body still lower, and with it the probability of reaction, by repeatedly emerging, and thus exposing the skin to the cooling action of evaporation. True it is that sea-

water more surely and speedily causes reaction and glow, and can, therefore, be indulged in for a longer period without exhaustion than fresh-water bathing. This difference is due to the stimulating properties of sea-water, and herein resides the only circumstance peculiar to sea-bathing. In all other respects the same advantages may be derived from fresh-water, but sea-bathing is more stimulating, refreshing, and bracing; nor can these beneficial effects be produced by any artificial solution of salts in water. Sea-water, moreover, evaporates more slowly, and hence the well-known fact of "not taking cold" so readily after sea-bathing. But another result is apt to ensue, equally uncomfortable, if not equally injurious. I allude to dryness of the skin with general feverishness. To obviate this objection, I would suggest that each bathing-machine should be furnished with a bucket of fresh water, and that on emerging from the sea, and while yet on the steps of the machine, this water should be used to cleanse the head and face more especially, of the saline matter, which, otherwise remaining, would dry upon the skin. Nor should the hair, in bathing, be kept dry or protected by any kind of cap. The headlong plunge, so much insisted on by some, is not essential to healthy reaction, and is, indeed, actually conducive to headache and lassitude subsequently. The bather should promptly enter the water and immerse the chest, to prevent spasmodic breathing, as soon as possible, and

the head be dipped immediately once or twice, to prevent cerebral congestion. The period for remaining in the water, I have already spoken of, and all other admonitions can be gathered from my previous remarks.

Any one of the foregoing remedies having failed, we may succeed with another; and hysteria more frequently yields under a succession of remedial agents, coupled with *social* treatment.

Preventive Treatment.—Is entirely non-medicinal, social causes lying at the root of the disease. Preventive measures consist in their anticipation, by the substitution of the opposite hygienic conditions of life. The experience of a late distinguished surgeon is here to the point, and an expression, I doubt not, of professional experience generally. You can render—observes Sir B. Brodie*—no more essential service to the more affluent classes of society than by availing yourselves of every opportunity of explaining to those among them who are parents how much the ordinary system of education tends to engender the disposition to these diseases—"nervous affections"—among their female children. If you would go further, so as to make them understand in what their error consists; what they ought to do, and what they ought to leave undone, you need only point out the difference between the plans usually pursued in the bringing up of the two sexes. The boys are sent at an early age to

* "Local Nervous Affections," 1837.

school, where a large portion of their time is passed in taking exercise in the open air; while their sisters are confined to heated rooms, taking little exercise out of doors, and often none at all, except in a carriage. Then, for the most part, the latter spend much more of their time in actual study than the former. The mind is over-educated at the expense of the physical structure, and, after all, with little advantage to the mind itself; for who can doubt that the principal object of this part of education ought to be, not so much to fill the mind with knowledge, as to *train* it to a right exercise of its intellectual and moral faculties, or that, other things being the same, this is more easily accomplished in those whose animal functions are preserved in a healthy state, than it is in others?

What, then, is the rational, remedial, and preventive treatment of hysteria, and, therefore, of one very frequent constitutional cause of the irritable bladder? Pathology suggests the answer—Certainly *not* the rash, repeated, and demoralizing introduction of a speculum to look after what? “a prominent spot of varying size”—“a something raised”—“an abrasion,” or “erosion?” Certainly not the indolent indulgence of a sofa-life. No; nor yet a round of fashionable excitement; but the due and daily occupation of the mind and heart with something better than mere passing circumstances: the *pursuit* of some *object* in life worthy of a rational and responsible being—the natural fulfilment of the instinctive

feelings—a timely and well-assorted marriage—in fine, the *equable adjustment* of every endowment of the nervous system—intellectual, moral, and physical. To this end, the resources of medicine may conduce, but cannot compensate for the want of those social requirements to which I have alluded.

Cerebral and Mental Diseases.—Sympathy between the bladder and the *brain*, through the agency of the nervous system, may be observed occasionally in certain cerebral conditions. “An elderly man, for example, complains of frequent attacks of giddiness. Sometimes in walking his head turns round, so that he is in danger of falling, and this symptom probably arises from an altered structure of the arteries of the brain, causing an imperfect state of the cerebral circulation. This state of things is sometimes attended with an irritable condition of the bladder; and although the urine is of a healthy quality, and the bladder itself is free from disease, the patient is tormented by a constant micturition, voiding his urine without pain, but at short intervals, and in small quantities at a time.”*

This disease is, perhaps, incurable; but, as Sir Benjamin Brodie truly remarks, by correct diagnosis we may avoid useless remedies.

The sympathy between the urinary bladder and the brain is illustrated, occasionally, by the influence of certain *mental maladies*; but although I have met with

* Lectures on the “Diseases of the Urinary Organs.” Sir B. C. Brodie, Bart.

many remarkable and interesting cases of this kind, the importance of the subject in relation to the physiology and pathology of the brain demands consideration beyond the limits of this treatise.

PREGNANCY MISMANAGED.

Having now considered those constitutional conditions, as they originate in the habits of society, of which irritability of the bladder is one very frequent and troublesome result, we approach the consideration of the *local* causes of this functional disturbance. There is one cause, however, which although of direct local operation on the bladder, is yet so constantly the result of habitual self-neglect as to demand our special attention. I allude to the mismanagement of Pregnancy. When conception commences, the ordinary functions of the uterus undergo a very remarkable change. Menstruation ceases as pregnancy begins. From the moment of conception the uterus gives warning to every part of the body of the changes which are going on within itself. At all times a vascular organ, and plentifully supplied with nerves, the gravid uterus becomes more vascular, and, perhaps, its nerves enlarge; and possessing these vital endowments, the uterus communicates through the vascular and nervous systems with organs most distantly removed from its

own locality. A slight rigor, or a feeling of faintness, may be the earliest constitutional symptom of pregnancy; or a slight febrile paroxysm may ensue. Very soon the whole body responds to the vital activity of the uterus. So all-pervading are the nervous endowments of the gravid uterus, that in this respect it may be regarded as almost *a second brain*, influencing and regulating the most distant organs during the whole period of pregnancy. Headache frequently supervenes. The natural temper and disposition of the woman may be altogether changed. The gentle and subdued may become irritable, and the melancholy become cheerful. Severe pains dart about the body, now affecting a single tooth, which may not be decayed, and anon settling for a time in the ear and face, or shooting through the breasts. The heart not unfrequently palpitates and distresses, while a troublesome spasmodic cough denotes the sympathy of the respiratory organs. Very shortly the digestive organs sympathize. The most extraordinary perversions of taste may occur, with a desire for cheese, pickles, or even for chalk and other unnatural substances. The mouth may overflow with saliva, and the well-known nausea and morning-sickness of pregnancy prove the intimate sympathy of the stomach. No less are the intestines engaged, for a troublesome and perchance dangerous diarrhoea may set in. And, lastly, though not in the order of occurrence, *incessant irritability of the urinary bladder*.

Thus every portion of the body responds more or less in turn to the influence of the gravid uterus, although its agency varies in different women. But the natural irritability of nearly every organ during pregnancy may obviously be regulated, if not subdued, by excluding those who are nervous and weak from undue participation in the pleasures, or even the ordinary duties of life. Rest and seclusion from society as pregnancy advances, will do much to control many unpleasant symptoms, which medicine can in no way remove, or even mitigate. The management of pregnancy is, therefore, a question of much interest, and of direct applicability to the treatment of many cases of irritable bladder. Its importance in relation to this condition should, however, be estimated by the *obstinate constipation* which is apt to occur during pregnancy, and I shall commence the next Section by a few remarks on this very frequent local cause of the irritable bladder.

SECTION II.

LOCAL CAUSES OF IRRITABLE BLADDER, AND THEIR TREATMENT.

HABITUAL CONSTIPATION AND DISEASES OF THE RECTUM
—HÆMORRHOIDS, EXTERNAL, INTERNAL WITH PRO-
LAPSUS RECTI—ULCER OF RECTUM, FISSURE IN ANO
—INFLAMMATION OF RECTUM—STRICTURE, FIBROUS,
CANCEROUS—ABSCESS ABOUT RECTUM—FISTULA IN
ANO—DISPLACEMENTS AND DISEASES OF THE UTERUS
AND VAGINA — STRICTURE OF THE URETHRA —
ENLARGED PROSTATE — HYPERTROPHY OF THE
BLADDER — CANCER — STONE IN THE BLADDER —
CYSTITIS, ACUTE AND CHRONIC—GONORRHOËA.

Habitual Constipation.—My own professional experience of the middle, and occasionally of the upper classes of society, convinces me that the error of habitual constipation from neglect of the suggestions of nature is still one of very frequent occurrence. False delicacy too often overrules the laws of nature in respect to the alvine evacuations, and torpidity of the bowels ensues from habitual inattention to her

dictates. The result is obvious. The bowels being loaded with feculent matter endeavour in vain to expel their contents. Hence they accumulate near the outlet of the rectum; the fluid portion of such matter is absorbed, and direct irritation of the adjacent bladder is apt to arise from pressure of the hard, dry, and impacted mass.

This result is more likely to occur during pregnancy. As the gravid uterus enlarges and encroaches on the capacity of the bladder and rectum, between which it intervenes, less space remains to accommodate any accumulation of fæces in the rectum. Such an accumulation frequently occurs during pregnancy, even although the bowels may apparently be relieved day by day; and therefore constipation and irritability of the bladder are frequent concomitants of pregnancy. Due attention to the suggestions of nature, aided by mild laxative medicines, such as castor-oil, will do much to relieve this troublesome local affection, and to prepare the way for a safe and easy delivery at the proper time of birth.

The use of the lavement has been daily resorted to in cases of rectal constipation; but the tone of the bowels is eventually impaired by the repeated adoption of this practice. In certain cases of habitual constipation it may prove necessary and useful, for we can scarcely hope to regulate the bowels by medicine when constipation is due to torpidity of the rectum. The

injection of a little *cold* water occasionally will often give the desired relief. The local irritation at once subsides, and the mental depression, which may have been suicidal, passes away as a morning mist disperses before the rising sun. The following anecdote is recorded of Voltaire:—"An English gentleman of fortune had been sitting many hours with this great wit and censurer of human character. Their discourse related chiefly to the depravity of human nature, tyranny and oppression of kings, poverty, wretchedness, and misfortune, the pain of disease, particularly the gout, gravel, and stone. They worked themselves up to such a pitch of imaginary evils, that they proposed next morning to commit suicide together. The Englishman, firm to his resolution, rose, and expected Voltaire to perform his promise, to whom the genius replied, 'Ah! monsieur, pardonnez moi, j'ai bien dormi, mon lavezement a bien operé, et le soleil est tout-à-fait clair aujourd'hui.'"^{*} Byron said that a dose of salts was more exhilarating than a bottle of champagne; and in one of his letters, "I am suffering from what my physician terms 'gastric irritation,' and my spirits are sadly depressed. I have taken a brisk cathartic, and to-morrow 'Richard will be himself again.'"

The local results of constipation of the rectum are illustrated, not only by irritability of the adjacent bladder, but also by irritation of the uterus; and I

^{*} "The Anatomy of Suicide." By Forbes Winslow, M.D.

have seen cases of leucorrhœa and hysterical symptoms which were aggravated by this form of constipation, if indeed they were not entirely due to that cause.

Certain diseases of the rectum may likewise cause irritability of the bladder.

Hæmorrhoids, External, or Internal with Prolapsus Recti, may be accompanied by much pain about the neck of the bladder, with a frequent desire to pass water. I have almost invariably found the following laxative of great service in this distressing condition:—Equal parts of the bitartrate of potash and powdered sulphur, mixed with honey, sufficient in quantity to form the consistence of an electuary.

One teaspoonful may be taken every night, if necessary; and its beneficial effect aided by the topical application of the Goulard lotion, or by the use of the unguentum Gallæ.

Medicinal treatment having failed, piles may be removed by excision, ligature, or cauterization.*

Irritability of the bladder is occasionally produced by *ulcer* of the *rectum*, just within the sphincter, or by *fissure* of the *anus*. Either form of ulceration affecting the mucous membrane may be scarcely visible externally; but the local irritation and acute pain will

* The Pathology and Treatment of Diseases of the Rectum and of the Genito-Urinary Organs—here viewed only in their causative relation to vesical irritability—are fully described in the author's "Science and Practice of Surgery."

suggest to the surgeon the propriety of making a further examination, and thus lead to the discovery of the real source of mischief. Recent ulceration, and of slight extent, may sometimes be healed by stimulant applications, as stick nitrate of silver, taking care to touch the spot exactly and with a decided twirl of the pencil; fissured anus, in like manner, by drawing the caustic point along the crack, so as to fairly touch the bottom of the angle. This must be followed by an anodyne suppository to allay pain, regulation of the bowels by castor oil, and scrupulous attention to cleanliness, to remove any source of irritation.

Old-standing and more extensive ulceration, or a confirmed fissure, can be cured only by section of the mucous membrane, by introducing a blunt-pointed bistoury, guarded by the finger, and drawing the blade downwards and outwards steadily, along the centre of the ulcer or bottom of the fissure, to the depth of about the eighth of an inch. A strip of oiled lint is then laid in the wound for a day or two. The only preparation for this simple proceeding is a thorough evacuation of the bowels, and the only after treatment an opiate, followed by a dose of castor oil in two or three days. The result is almost instantaneous relief, and a permanent cure.

Inflammation, with or without ulceration of the rectum, may occasion irritability of the bladder; and *stricture* of the bowel—fibrous or cancerous—discovered

by rectal examination with the finger, may torment the sufferer with the most distressing desire to void the last drop of urine.

This symptom seems partly due to fæcal accumulation in the rectum, but principally to the irritation arising from the diseased bowel, and especially, therefore, when the stricture is malignant.

Either form of stricture presents to the touch its own diagnostic peculiarities; the fibrous being more limited in extent, sometimes annular, or semi-lunar; whereas the cancerous is usually more extensive, and has an irregular nodulated surface, with cartilaginous induration,—if scirrhus, or like a soft cushion,—if encephaloid cancer. In the ulcerative stage, the finger is withdrawn covered with bloody, slimy mucus, or purulent discharge. Frequent constipation, with straining efforts in defecation, and the passage of scanty, narrowed, and figured or lumpy fæces, are symptoms common to both forms of stricture; but scalding pain, like the passage of molten lead, is distinctive of cancerous stricture, and in its ulcerative stage. Dilatation is the principle of treatment, but bougies must be used with great caution with regard to the course and diseased state of the canal, lest the bowel be injured.

Lastly, abscess in the neighbourhood of the rectum, as for instance in the ischia-rectal fossa, or between the prostate and rectum, very constantly produces frequent and difficult micturition.

An *abscess* about the rectum should be opened freely and at an early period. But the skin around the anus may be so thick and brawny as to disguise the usual character of an abscess, and disarm all suspicion that suppuration has commenced. Moreover, as suppuration proceeds, the matter may find its way backward and upward, along the bowel, for a considerable distance, rather than *point* towards the unyielding skin. When, therefore, at any spot the slightest *fluctuation* is perceptible, then and there should a bistoury be entered, and the opening freely enlarged, if matter is discovered. I think that by this active precaution I have, in many instances, at the Hospital and elsewhere, prevented a worse result. For, when an abscess in the neighbourhood of the anus has burst spontaneously, it may contract and partially close up, leaving a narrow channel which opens either externally—at some spot in the vicinity of the anus, or internally—into the bowel, or communicates both externally and internally, constituting a complete *fistula in ano*. Either of these conditions is accompanied by a constant fetid purulent discharge, with much pain, irritation, and misery, which undermine the general health.

The introduction of a probe, or director, through the external opening in the skin, will guide to the internal opening, should it exist, or to a spot where the bowel is thin and about to give way. Then the

forefinger of the other hand is introduced into the rectum until it rests upon the point of the director. A curved, sharp-pointed bistoury is introduced through the external orifice of the fistula, along the groove of the director, until it touches the finger in the rectum, when the sinus should be freely laid open into the bowel, and afterwards dressed and healed from the bottom. If more than one sinus exists, similar proceedings are necessary. This operation will alone insure a radical cure, but requires some caution in its performance.

The introduction of a sharp-pointed and cutting instrument along a fistula in ano is attended with some risk. Percival Pott said, truly, that "in all chirurgic operations the instrument made use of cannot be too simple, nor too keen, and, if possible, should never be out of the sight, or the direction of the finger, of the operator; and whenever it is (as must sometimes necessarily be the case), it is liable to some degree of uncertainty;" but the fistula-knife, if *pointed* and so *keen*, may pass out of the sinus towards the bowel, or even towards the bladder. I do not say that such a catastrophe will happen in the hands of an experienced surgeon; but I do say, that the ordinary bistoury in use is not adapted, by its construction, for the operation for fistula in ano. This is specially the case, if the fistula be long, narrow, and tortuous. Having myself experienced some incon-

venience in the use of a pointed bistoury with an unprotected blade, I some years since invented a *concealed knife*,* which has the appearance of an ordinary director, with the handle of a scalpel. *This* director is passed through the fistula into the bowel when, by touching a button on the back of the handle, the instrument is *then* converted into a knife, having a sharp point, which can be passed through the bowel, if the fistula be incomplete; and the operation finished in the usual manner. Thus, also, the previous introduction of first a director, and then a bistoury, is rendered unnecessary. The operation is begun and completed with but one instrument, by a more simple, speedy, and safe operation.

This concealed fistula knife—when made of a smaller size—I have found very useful in cases of ulcer of the rectum, or of fissured anus; also in phymosis, by simply passing it under the foreskin, which is then drawn back with one hand as the instrument is withdrawn by the other. I may mention that in many cases of phymosis it is unnecessary to divide the whole thickness of the prepuce. If the under thin skin *only* is divided, the prepuce may frequently be drawn back without dividing the outer more sensitive skin. The retracted foreskin should then be enrolled in a slip of wet lint; no sutures are required, and this more

* Catalogue of Surgical Instruments, &c. Illustrated. Messrs. Weiss. 1866.

simple operation is attended with less hæmorrhage, far less pain and eventual disfigurement.

A modification of the same instrument is equally useful as a *guarded hernia knife* for division of the stricture of hernia.

I may here mention that I cannot coincide in the statement advanced by M. Ribes in 1820, and previously, I believe, by Sabatier, that the inner opening of fistula in ano is never higher up in the bowel than five or six lines from the anus. This view is supported by Sir B. Brodie, who says, "The inner orifice is, I believe, always situated immediately above the sphincter muscle, just the part where the fæces are liable to be stopped, and where an ulcer is most likely to extend through both the tunics." The equally high authority of Mr. Syme, and the special observations of Dr. Bushe, of New York, tend to the same conclusion; but Mr. Curling disproves the statement of M. Ribes, and although Mr. Quain does not take up the question in his clinical lectures on Diseases of the Rectum, yet the facts there adduced are equally opposed. In Case 29 of the lectures referred to, the inner opening of the fistula was more than two inches up the rectum, and it was situated equally high up in Case 32. I would add, that I once operated on a man, in the hospital, for complete fistula, the inner orifice of which was three inches from the anus; and

in that case I also removed a portion of dead bone from the tuberosity of the right ischium, after which the patient recovered.

DISPLACEMENT AND DISEASES OF THE UTERUS AND VAGINA

might readily be supposed to disturb the function of the bladder. The contiguity of the uterus and bladder, and the vascular and nervous connexion subsisting between these organs, and the rectum, will fully explain their mutual sympathy. *Displacements* of the uterus and vagina operate mechanically. Prolapsus vaginæ pulls down the bladder, and thus induces irritability, or perhaps incontinence; and prolapsus uteri operates in a similar manner, and at a very early period of such displacement, before the position of the bladder is altered. Among *Diseases*, acute inflammation of the uterus is noticed by Dr. H. Bennet as a local cause of vesical irritability; and cancer and fibrous tumours of the uterus have a similar effect on the bladder.

STRICTURE OF THE URETHRA.

Stricture of the urethra is a well-known local cause of vesical irritability. Among the advanced symptoms of this disease, there is none so constant, painful, and

distressing as the frequent and unavailing efforts to relieve the bladder. The urine now dribbles or drops, and never flows in a full and unbroken stream. Each act of micturition is imperfect, and the bladder is never emptied. As constantly does that organ contract, and endeavour to evacuate its contents. The "muscular coat" of the bladder gradually strengthens and thickens, in order to compensate, if possible, for the extra force now required to eject the urine through the strictured urethra; and as this thickening proceeds, the capacity of the bladder is proportionably diminished, less urine can be retained, and micturition must, therefore, be more frequent. The bladder is irritable, owing to its diminished capacity, and thus the pathology of stricture with vesical irritability is partly a hydraulic question. The reservoir of urine is drawn off, perhaps, more effectually as occasion may require during the watchful hours of day, and during that period the desire to pass water may, therefore, be less urgent and distressing; but, at night, when exhaustion would invite to rest, the sleepless irritability of the bladder repeatedly arouses the sufferer from his temporary doze. In vain he tries, by every conceivable change of posture which instinctive feeling may suggest, to seek repose. His bladder still torments him, and the night is passed in restless efforts to obtain relief. The most easy position in such a case is the recumbent, with the buttocks raised. By this adjustment, the

urine is thrown back from the more sensitive portion of the bladder on to a part less acutely irritable.

Spasmodic stricture may occur at any portion of the urethra from contraction of the involuntary muscular fibres which encircle it throughout its course; or the membranous portion of the urethra may be constricted by spasmodic action of the compressor urethræ muscle, which acts as a sphincter on this portion of the passage. In such cases, the urine is frequently very acid, and that is the direct cause of irritation. The indulgence over-night of acid wines, punch, food containing peppers of various kinds, or other stimulating condiments, may be followed next morning by an attack of spasmodic stricture, which, unlike the permanent stricture already noticed, is only of temporary duration, and after a while subsides; or a spasmodic attack may be super-added to, and aggravate, the results of permanent stricture. In either case the temporary spasm is frequently due to irregularities of diet, and such as occur more especially among the affluent classes of society. Hence the constant association of a gouty condition with this form of stricture.

The restraints of society may almost compel an individual to postpone the act of micturition far beyond the time when desire is urgent, and this retention of urine, itself, perhaps, highly acid and irritating, will favour the occurrence of spasmodic stricture. The enjoyment of convivial life may thus end in much suffer-

ing and distress. Nor should the influence of outdoor amusements be forgotten. Rough riding on horseback—as, for instance, across a ploughed country—may so bruise the urethral passage as to induce spasmodic stricture. The experience of most surgeons will remind them of many instances of this kind—among those who go down for the hunting season, or those, perhaps, who, being unaccustomed to horse exercise, are wont to attempt the sports of the field. Under these circumstances, spasmodic stricture may occur. But the picture may be reversed, and among the poor and the destitute who throng our hospitals, this condition is of daily occurrence during the winter months. The combined effects of cold and exhaustion drive many a homeless wanderer to seek relief at an hospital during the early hours of our winter mornings.

Lastly, spasm of the urethra may be due to certain mental conditions, which operate through the nervous system; and Sir A. Cooper notices in this respect the influence of anxiety and over-study as causes of stricture.

Inflammation of the urethral mucous membrane may occasion a species of temporary stricture. This condition may be the result of *gonorrhœa* when retrocedent, or suppressed by the use of injections, during the inflammatory stage; and that frequent cause of inflammatory stricture may be aided by the inconsiderate use of alcoholic liquors and a stimulating diet. In

such cases, I have observed the penis to be turgid and erectile, and the urethra bleeds freely on the introduction of even a moderate-sized catheter. The urethra is acutely sensitive, and intense scalding is felt on passing water, which is shot out at short intervals from the now irritable bladder. In all these respects, the symptoms of inflammatory stricture, so called, contrast with those produced by spasm.

The treatment of gonorrhoea is noticed at page 80.

The relief of stricture—whether organic, spasmodic, or inflammatory—will relieve the concomitant irritability of the bladder.

The first-named variety of stricture yields most successfully to *gradual* dilatation; at the same time, the instruments of Mr. T. H. Wakley will be found useful in certain cases of very tight stricture, through which “the director” having been introduced with, perhaps, considerable difficulty, we are then too happy to retain this guide to the bladder, rather than, by withdrawing the instrument, have again to encounter the obstacles and false passages which perchance first opposed its introduction. It is all very well to say that if an urethra be pervious, an instrument which has been passed once may be re-introduced; but that is not the question. The instrument has been passed with, perhaps, considerable difficulty, and the re-introduction of one of larger size may, therefore, be scarcely practicable.

In such a case, we may, I think, gladly avail ourselves of the advantage gained by Mr. Wakley's director and series of instruments. The operation of "splitting," as performed with Mr. Holt's dilator, is likely to entirely supersede this or any other method of *immediate* and *forcible* dilatation.

Cauterization is unwarrantable as a method of treating any purely organic stricture. Division of a stricture is a resource which comprises—internal urethrotomy, or external urethrotomy, usually perinæal section.

All these modes of treatment for the cure of organic urethral stricture are fully described, compared and estimated, in my work on Surgery (Science and Practice).

In the event of spasmodic stricture, repeated attempts to introduce a catheter are unwarrantable. The spasm is more likely to yield under the influence of a warm bath, coupled perhaps with a draught containing ten minims of Battley's sedative. I have used a drachm or more of the compound tincture of camphor with advantage. Chloroform, cautiously administered, has relaxed the spasm. I have not seen much good result from the use of suppositories. The beneficial effect of the warm bath and of antispasmodics is most obvious in cases of spasm after exposure to cold; but should the gouty diathesis of the individual or the history of the case point to acidity of the urine,

then the use of alkalies and other measures will at once suggest themselves.

The inflammatory stricture, so called, which follows suppressed gonorrhoea will subside on the reappearance of the discharge, and I have often recommended the glans penis to be enclosed in a poultice, and have found this simple remedy successful.

DISEASES OF THE PROSTATE GLAND.

The prostate gland may become *enlarged*, and induce irritability of the bladder. The more common form of chronic hypertrophy, unaccompanied by any obvious change of structure of the gland, is that to which I now refer. The commencement of this condition, so common in advanced life, is often very insidious. The prostate may have enlarged considerably without interfering with the act of micturition. Months, or perhaps years, may elapse before any inconvenience arrests attention. At length some delay—not to say difficulty—in passing water is experienced. The desire to micturate is more frequent, if not painful. Pain is often felt in the glans penis; but this symptom, unlike the pain from stone in the bladder, is not more acute after micturition. But each act is felt to be incomplete and is unsatisfactory. A man may have long suffered from these symptoms, and if, when examined, the finger be passed up the bowel, his enlarged pros-

tate will be readily detected, and by tilting upwards and forwards the base of the bladder, more urine may be expelled.

Pathology supplies the true explanation of all these symptoms. The enlarged prostate projects upwards into the bladder (sometimes backwards towards the rectum), and urine accumulates behind the prostate. The bladder is never emptied below the level of the prostate. If, therefore, the lower fundus of the bladder be tilted forward by the finger, or by altered posture, and a catheter introduced, a pint or more of urine may be drawn off from a reservoir which had apparently been drained. Then the bladder gradually fills again; but not until the urine rises above the level of the prostate, can the act of micturition occur. The surplus "overflow" passes off, when the bladder is sufficiently distended to obey its own contraction, and the straining compression of the abdominal muscles to overcome the resistance offered by the enlarged prostate.

The progress and closing scene of this disease are similar to the history of retention from stricture. The muscular coat of the bladder thickens and projects inwardly, in the form of large muscular bands, between which the mucous membrane protrudes externally, and becomes sacculated under the constant pressure of urine. Congestion of the mucous membrane ensues, its colour changes to a greyish slate

hue, and blood, viscid mucus, or purulent matter, is voided with the urine, which is now alkaline and foetid. The backward pressure of urine distends, and eventually dilates, the ureters; while the substance of the kidneys becomes atrophied; and suppressed secretion of urine, retention of urea in the blood, coma and death, terminate the patient's sufferings.

But little can be done to cure—much to alleviate—the symptoms of enlarged prostate. The hydraulic results, as I would term them, and concomitant vesical irritability, may be relieved by drawing off the urine, as occasion requires. The *prostatic* catheter should be full-sized, longer, and more curved than the ordinary catheter; for these peculiarities of construction are necessary to adapt that instrument to the alteration of the urethra in respect to its length and direction, produced by the enlarged prostate; but the prostatic catheter usually sold in the shops is, I think, rather a caricature of what is required. If the patient be taught to introduce a catheter somewhat longer and more curved than the instrument used for ordinary stricture, he may live on for some years in comparative ease and comfort. The medicinal treatment which will aid this happy quietude I shall notice in connexion with inflammation of the bladder. The efficiency of such treatment will depend on the stage of the disease. When structural changes of the bladder and kidneys have ensued, the beneficial operation of all

medicinal agents will obviously be impaired. No mode of treatment at present known can repair the structural degeneration of the kidneys; nor can hypertrophy (overgrowth) of the bladder be reduced. This leads me to make a few remarks on the latter condition.

DISEASES OF THE BLADDER.

Hypertrophy of the bladder may be the result of an enlarged prostate, of stricture, or, indeed, if any condition which induces habitual retention of urine, or by interfering with its free evacuation as occasion may require, overtaxes the contractile power of the bladder. Its muscular coat is, therefore, the portion chiefly affected, and eventually becomes hypertrophied—a change which any muscular tissue would undergo by habitual over-exercise. No other structural change may accompany this condition; but the bladder is over-irritable, owing to its diminished capacity, and cannot, therefore, retain its contents for the average period. Micturition is more frequent.

This functional activity should be distinguished from incontinence arising from weakness of the neck of the bladder, and possibly connected with structural disease or malformation—a condition in which the urine dribbles away continuously, and is not shot out at short intervals, as from the bladder when irritable. I have

already noticed the distinction between overflow and complete retention of urine. The former term denotes the *regorgement* of French authors, and indicates partial retention.

It is of great practical importance to bear in mind the pathological distinction between, and significance of, these various morbid conditions—retention of urine, occasional overflow, dribbling incontinence, and frequent micturition from vesical irritability.

The latter perversion of function has been traced in the foregoing pages to the influence of certain constitutional causes, which operate either through the medium of the blood's circulation, or through the nervous system; and also to many varieties of local disease which occur in the neighbourhood of the bladder; but *organic* diseases of the bladder itself are, moreover, occasional causes of irritability. Certain supplemental growths, whether benign or malignant, may invade the proper structure of the bladder, and occasion irritability.

Cancer, generally the soft variety, must thus excite more frequent and painful micturition. The pain, at first endurable, and referred to the loins, hips, or lower part of the belly, increases in severity, but is scarcely ever lancinating. The urine is ejected, perhaps, every few minutes, and as ulceration of the bladder ensues, is expelled with sweating agony. The semen may be emitted, and the contents of the bowels evacuated, or

the bowel itself protruded, during this writhing effort to strain off the last few drops of urine. Profuse hæmorrhage often accompanies or follows the act of micturition; or the urine may be bloody, alkaline, fœtid, and purulent, and cancer-cells be seen under the microscope. All these suspicious symptoms are corroborated by the discovery of a solid tumour at the lower part of the abdomen; but is such tumour malignant or benign? Constitutional symptoms cannot, I think, decide this question; for although the general health may break down under sleepless suffering, yet the peculiar *cachexia* of cancer is rarely present, even at an advanced stage of this disease, when affecting the bladder. The microscope and the general severity of the bladder-symptoms will, perhaps, determine our diagnosis. Very little can be done in the way of curative treatment; but the tormenting irritability can be somewhat allayed by measures which will be more conveniently noticed in the sequel.

Stone.—No less frequent and intolerable is the desire to void urine, which announces the presence of stone in the bladder. The vesical irritability and straining effort are most painful *after* each oft-recurring act of micturition; for as the urine runs off, the stone is floated down, and settles on the more sensitive neck of the bladder. The least movement of the body is now communicated to the stone, which rolls about with every change of posture. Personal experience soon

restrains the patient's movements. He walks about stealthily, and shuns any sudden or violent exertion. Ask him to ride on horseback, or to jump off a chair, and he at once refuses. He feels more acute pain in the glans penis than elsewhere, and this is aggravated *after* each act of micturition. At that time, or after rough exercise, the urine is more or less bloody from attrition of the stone and interior of the bladder, and the stream of urine may flow freely, unlike its passage through a strictured urethra, but cease abruptly, should the stone be washed down suddenly on to the neck of the bladder. All these symptoms of stone are directly due to its mechanical action; and should a calculus not be freely moveable, but encysted in the coats of the bladder, we may look in vain for any ordinary symptoms of its presence. In this and all other cases of suspected stone in the bladder, we must, I need scarcely say, trust the less doubtful evidence of *sounding*, to detect the cause of vesical irritability. This touchstone is conclusive, when available. The physical signs of a hard body, such as a stone, and which can be transmitted through a metallic instrument to the hand and ear, are far more conclusive than all the mere functional symptoms of its presence. All the symptoms of stone are absent in some cases, as in those of encysted calculus; or the symptoms, including evidence derived from sounding, may be masked by enlargement of the prostate. I remember to have

heard from the late Mr. Thomas Morton (surgeon to the University College Hospital) of a case which occurred in his practice, and in which an instrument had been constantly passed by many eminent surgeons during a period of fifteen years, and yet no stone was discovered until after death. The pain and vesical irritability may be characteristic, but these symptoms are occasionally absent. Sir Benjamin Brodie, I believe, first noticed the fact that stone in the bladder causes less pain when the prostate is enlarged than when of its average size; and the comparative ease in such a case is probably owing to the enlarged prostate protecting the more sensitive neck of the bladder from the weight and friction of the stone.

Then again, other diseases may produce symptoms of vesical calculus. A pedunculated growth in the bladder may, during micturition, flap over the urethral orifice and abruptly arrest the flow of urine. Hæmorrhage may indicate ulceration of the prostate, or malignant disease of the bladder. Lastly, the pain and vesical irritability of stone may be due to either testicle being impacted and inflamed within the inguinal canal.

We should not therefore be misled by the presence of any one symptom of a given morbid condition, but be guided rather by an *association* of the symptoms to determine our diagnosis. Irritability of the urinary

bladder is one result of many causes, and with the view to their discovery and removal, I have endeavoured to sketch an outline of the various diseases with which that condition is connected. In conformity with this design I would now review the history of another local disease, a prominent symptom of which is vesical irritability.

Cystitis—inflammation of the bladder—is a somewhat rare occurrence. The symptoms of this condition somewhat resemble those of vesical irritability. The painfully urgent and oft-recurring desire to drain the last drop of urine, and straining effort to do so even when the bladder is empty, are symptomatic of irritability; but the pain on pressure over the hypogastrium and the character of the urine, now loaded with mucus, pus, and phosphates, proclaim the presence of an inflamed mucous membrane. Retrocedent gonorrhœa will occasion these symptoms; but certain other diseases already noticed, such as stricture, enlargement of the prostate, and stone in the bladder, induce a more chronic form of inflammation.

The treatment of gonorrhœa becomes a question of considerable interest and practical importance, when viewed as a cause of stricture and occasionally of cystitis. If the discharge be too suddenly suppressed by injudicious treatment, either or both of these untoward results are apt to ensue: and as it falls to my lot to manage very many cases of gonorrhœa, I may

mention that I almost invariably prescribe with success a gentle aperient and alkaline mixture containing senna, sulphate of magnesia, and the sesqui-carbonates of soda and ammonia. The urine is thus neutralized and rendered less irritating to the inflamed urethra; while the inflammation itself is gradually reduced by the hydragogue operation of the aperient. If this simple mode of treatment be persisted in for about three weeks, and aided by abstinence from wine, beer, spirits, and a stimulating diet, the inflammation will most probably have *safely* subsided. The discharge is no longer copious, thick, and sulphur coloured, but scanty, thin, and transparent. This *gleet* may be safely suppressed by using an injection twice a day, consisting of about two drachms of the liquor plumbi diacetatis to two ounces of water. I do not find it necessary to prescribe copaiba or cubebs: and I have seen the worst results from an injection containing the sulphate of zinc.

Should *acute* inflammation of the bladder supervene from this or any other cause, then the recumbent position is in itself curative. By this posture, the bladder is relieved of the whole weight of the upward column of blood. The bowels should be kept free to prevent irritation, and to derive from the bladder. Glsters of opium may do something to allay the distressing irritability. If the urine is acid, and its sediment yellowish and not coherent but purulent, Sir B. Brodie

recommends a pill of calomel two grains, with half a grain of opium, to be taken twice or three times a day. On the other hand, if the urine be alkaline and present a small quantity of brownish adhesive mucus, the same authority recommends fifteen minims of the vinum colchici to be administered thrice daily, for three or four successive days.

Chronic inflammation of the bladder is denoted—when idiopathic—by an abundance of thick, tenacious, greyish mucus in the urine, which gradually subsides to the bottom of the vessel in which it is collected. This deposit may be tinged with blood, or present white streaks of phosphate of lime; and, as the viscid mucus increases in quantity to, perhaps, nearly equal the bulk of urine, it can be poured from its receptacle, in long coils, something like maccaroni. The urine itself becomes brownish, very ammoniacal, and foetid; shiverings and great prostration are ominous of a fatal issue. The appearance of the bladder and ureters after death corresponds to that already mentioned as resulting from chronic stricture—prostatic enlargement—and stone in the bladder. Can aught be done to anticipate the fatal issue of this disease—to arrest the muco-purulent discharge from the bladder, and to allay its irritability? The recumbent posture is still of cardinal importance. The general treatment recommended for acute inflammation is also appropriate; but Sir B. Brodie lays so much stress on the remedial value of a *concentrated*

mixture of the *pareira brava*, that I am induced to give his recipe for that preparation:—"Take half-ounce of the root; add three pints of water, simmer gently near the fire down to one pint." From eight to twelve ounces of this decoction should be taken daily. If the extract of *pareira* is preferred, then thirty grains of it are equal to half-a-pint of the above decoction. The decoction of *uva ursi*, or the infusion of *buchu*, may aid in checking the muco-purulent secretion; but the mineral acids, coupled with *pareira brava*, will do so more effectually. The nitric or muriatic acids are, I think, peculiarly serviceable; yet more so when the urine itself is alkaline, than when it subsequently becomes so by admixture with alkaline mucus in the bladder. This latter opinion of Sir B. Brodie is confirmed by the observation of Dr. Owen Rees.* Benzoic acid also renders alkaline urine, acid.

I have found *gallic acid* useful in arresting the secretion of ropy mucus. And, when all acute symptoms have subsided, injections of tepid water, or decoction of poppies, in quantities of not more than two ounces, and retained for half a minute once a day, are recommended by Sir B. Brodie, who also speaks favourably of the diluted nitric acid, in the proportion of ten minims, *gradually* increased to twenty, in two ounces of water, used as an injection. By these measures, coupled with tonics and a generous diet, to support the

* "Alkaline Urine," Guy's Hospital Reports, 3rd series, vol. i., 1857.

dread exhaustion of chronic cystitis, we may succeed in arresting the progress of this disease to a fatal termination.

The foregoing appropriate treatment of cystitis should, of course, be coupled with the removal, if possible, of any local cause or predisposing constitutional condition with which that disease may be associated. Is inflammation of the bladder due to the friction and irritation of a calculus? Is, in fact, cystitis a symptom of stone in the bladder? Then that condition of inflammation can only subside on the removal of the stone as an exciting cause. Lithotomy or lithotrity is indicated. If chronic enlargement of the prostate, or stricture of the urethra, be the cause, treatment must have regard to either of these conditions. Does cystitis supervene on suppressed gonorrhoea—the restoration of the discharge is a rational principle of treatment. If the urine be turbid, with a brick-dust deposit of lithates, in conjunction, perhaps, with habitual irritable dyspepsia and a gouty constitution, then the correction, if possible, of that constitutional tendency is clearly indicated.

In fine, the urinary bladder has its *nervous* and *vascular* relations to surrounding organs, and to parts distant in the body. The bladder may, therefore, be affected by many local diseases, which cluster around and operate as disturbing causes of its own condition of health, whether functional or perhaps structural, in

either way inducing vesical irritability; and moreover, this organ is affected by many constitutional diseases, *i.e.*, of the blood (and of the nervous system), themselves referable to mal-assimilation, or to mal-excretion, the influence of which diseases is manifested by, if not concentrated in, the urinary bladder, through accompanying morbid conditions of the urine, which are the immediate causes of the vesical irritability thus induced.

It was, therefore, consistent with the design of this monograph to review the pathology and appropriate treatment of those *local* diseases which conspire to excite the frequent and painfully urgent desire to micturate, significant of irritability of the urinary bladder.

It remains for me to consider the pathology of the *urine*, with that also of *constitutional* causes—as represented by blood diseases; and hence, the appropriate treatment of vesical irritability, as arising from this large class of causative conditions.

SECTION III.

URINARY PATHOLOGY, AND TREATMENT OF IRRITABILITY OF THE BLADDER.

CONSTITUTIONAL CAUSES—MORBID CONDITIONS OF BLOOD, BY MAL-ASSIMILATION, IN THE PROCESS OF NUTRITION, OR OF DIGESTION, OR BY MAL-EXCRETION, THROUGH KIDNEYS, SKIN, OR LIVER — DISEASES ASSOCIATED, AND THE ACCOMPANYING MORBID CONDITIONS OF URINE AS THE IMMEDIATE CAUSES OF VESICAL IRRITABILITY—THE PHYSICAL AND MICROSCOPICAL CHARACTERS, AND THE CHEMICAL TESTS OF THESE CAUSATIVE CONDITIONS, WITH THEIR DIAGNOSTIC INTERPRETATION AND VALUE AS CONSTITUTIONAL SYMPTOMS — TREATMENT — CURATIVE ; DIETETIC AND MEDICINAL, AND PREVENTIVE.

URINARY PATHOLOGY is best introduced by observing the characters and composition of the urine in health, as the representative and exponent of blood-conditions in health.

HEALTHY URINE.

Physical Characters.—A fluid, clear, of a bright amber colour, peculiar aromatic odour, and specific gravity or weight, varying from 1·015 to 1·030, the average being 1·020; the quantity secreted varying from 30 to 80 fluid ounces in twenty-four hours, the average being about 52 ounces. Slightly acid, except after food, when it becomes neutral or alkaline, during digestion in the stomach—chymification.

Chemical Composition or Constituents—qualitative and quantitative.—Mean or average in twenty-four hours, for the adult male:—

	Grains.
Urea	512·40
Uric acid	8·56
Phosphoric acid	48·80
Oxalic acid	1·42
Sulphuric acid	31·11
Hippuric acid	34·50
Chlorine	126·76
Extractives*	154·00
Soda	125·37
Potash.	58·21
Ammonia	8·58
Lime	3·55

* *E.g.*, creatine and creatinine, and colouring matters.

		Grains.
	Brought forward	1113·26
	Magnesia	3·09
	Iron	undetermined
	Mucus (adventitious)	7·00
<hr/>		
Total {	Solids	1123·35 Grains, weight.
	Water	52½ Ounces, measure.

In estimating the quantity of any urinary constituent excreted in twenty-four hours, the weight of the body and activity of the functions must both be compared therewith. Thus, the excretion of only 150 grains of urea, in a person whose weight is 80 lbs., would be a healthy proportion; but if the weight be 170 lbs., that quantity would be very disproportionate, and indicate a diseased condition of serious or fatal consequence.

The physiological origin of the urinary constituents is represented in the following tabular view, taken from Dr. Golding Bird's well-known work.*

1. *Organic Products.*

1st. Ingredients characteristic of the secretion produced by the destructive assimilation of tissues, and separated from the blood by the kidneys.	} Urea, uric acid, creatine, creatinine, colouring and odorous principles.
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* "Urinary Deposits," &c. Edited by Dr. Birkett. 1857.

2nd. Ingredients developed principally from the food during the process of assimilation.

In addition to the above, hippuric acid, lactic acid; accidental constituents.

2. *Inorganic Products.*

3rd. Saline combinations separated from the blood, and derived from the food.

Sulphates, phosphates, chloride of sodium, and all soluble salts taken with the food, and often undergoing decomposition in the system.

4th. Saline combinations chiefly generated during the process of destructive assimilation.

Sulphates.
Phosphates.

3. *Ingredients derived from the Urinary Passages.*

5th. Mucus of the bladder.

6th. *Débris* of epithelium.

7th. Phosphate of lime.

Morbid conditions of the urine are—either increased or diminished proportions of its normal constituents,

or new adventitious ingredients, those, perhaps, of most practical importance being sugar, albumen, and bile.

The urinary bladder can well tolerate the normal urinary constituents, *i.e.*, healthy urine, which only sufficiently irritates that organ to suggest, from time to time, the evacuation of its contents, as the temporary receptacle of this excretion. But if either of the many constituents adverted to be secreted in excess, or if some new one be present, the bladder at once rejects the unaccustomed urine, the functional condition of excitement, irritability of the bladder, with, therefore, too frequent and painfully urgent micturition, is induced.

Morbid conditions of the urine are, in common with its healthy conditions, immediately referable to corresponding causative conditions of the blood; but their pathological *origin*—like unto the physiological origin—within the body is remote.

MORBID CONDITIONS OF THE BLOOD.—In health, the composition of the blood is ever-changing, by the addition of new matter, received through the process of digestion,—the primary assimilation of food, and as effete matter or waste of the textures, through their destruction in the course of nutrition,—secondary assimilation; and, furthermore, ever-changing, by the abstraction of old, effete matter, or excretion, through the kidneys, skin, liver, and other excreting and secreting organs.

So likewise, in various diseases, the composition of the blood is ever-changing, by the addition of new morbid matter, through primary *mal*-assimilation, or secondary *mal*-assimilation, or by the co-operation of both these perversions, the former representing that of digestion, the latter that of nutrition; and, furthermore, ever-changing, by the non-abstraction or retention of morbid matter, *mal*-excretion, through the kidneys, skin, liver, and other excreting and secreting organs.

(1) *Mal-assimilation (a) in Nutrition*.—This source of blood-disease was first investigated by Prout,* and afterwards, physiologically, by Liebig,† who designated the destructive stage of nutrition “destructive metamorphosis” of tissues. Prout was inclined to believe that in all cases of secondary *mal*-assimilation, the *formative* and *destructive* stages of this process are both perverted in a greater or less degree.

The various kinds of textures, as chemically distinguished—the albuminous, the gelatinous, the oleaginous—may severally generate morbid conditions of the blood, by their *destructive* metamorphosis in secondary *mal*-assimilation.

Lithic Acid ($C_{10}H_4N_4O_6$).—Albuminous tissues undergo decomposition into lithic acid, rather than lithate of ammonia; and the blood being thence surcharged with this acid, represents the “gouty diathesis.”

* “Nature and Treatment of Stomach and Renal Diseases.”

† “Animal Chemistry.” Translated by Gregory. 1842.

Urea ($C_2H_4N_2O_2$), in like manner, resulting from the normal destructive metamorphosis of highly nitrogenous tissue—*e.g.*, muscle—may possibly be produced in excess, by such transformation taking place too rapidly for excretion, by the urine, to eliminate it proportionately; or, again, the excess may possibly arise from uric acid by its oxidation, as urea can be thus formed artificially.

Phosphoric Acid (PO_5).—Textures abounding in phosphoric acid, *i.e.*, the brain and nervous system, by their destructive metamorphosis in an over-active degree, induce the “phosphatic diathesis.” The blood is surcharged with this acid, in combination with alkaline and earthy bases, forming, respectively, phosphates of soda, and those of lime and magnesia. The *deposition* of the *latter* in the urine, the only phosphates ever *deposited*, does not represent their total amount, but only the alkalescence of the urine, as explained under “phosphatic urine.” One general law appears to govern the evolution of phosphoric acid and the formation of phosphates: they always follow nervous exhaustion, particularly that resulting from over brain-work. Of this source, two excellent examples are given by Golding Bird, one of which I incidentally alluded to at p. 26.

Oxalic Acid (HO, C_2O_3). — The gelatinous textures may possibly, according to Prout, by their destructive metamorphosis, be converted into oxalic acid, which,

entering the blood, represents the "oxalic acid diathesis."

Sulphuric acid (HO, SO_3), derived chiefly from the oxidation of the sulphur in the destructive metamorphosis of the albuminous tissues, will, therefore, be produced in excess by their too rapid and abundant transformation in this stage of secondary assimilation. The oxidation of cystine and taurine is another probable source.

Hippuric acid ($\text{HO}, \text{C}_{18}\text{HNO}_5$), a highly carbonaceous acid, may, perhaps, be produced in excess by the destructive metamorphosis of nitrogenous tissue.

Lactic acid ($\text{HO}, \text{C}_6\text{H}_5\text{O}_5$), in excess, may also have a similar origin; muscular tissue everywhere abounding in lactic acid.

Chloride of sodium (NaCl) and chloride of potassium (KCl), in excess, are, perhaps, produced by the destructive transformation of the tissues in general.

Sugar of the grape—glucose ($\text{C}_{12}\text{H}_{12}\text{O}_{12}$) in the blood—and thence the origin of diabetes mellitus, may possibly proceed from the gelatinous textures (Prout); but the liver-origin of the glucose from glucogen, as shown by Claude Bernard, is now the generally admitted source.

(b.) *In the process of Digestion*, perversions of primary assimilation generate morbid conditions of the blood, similar to those which emanate from perversions in the course of nutrition.

The perversions in question are referred by Prout to the stomach, the duodenum, and the chyliiferous system.

Lithic acid may be a product of the imperfect digestion of albuminous food in the stomach. Mal-assimilation in the duodenum generally results from that in the stomach, and that which takes place in the chyliiferous system of vessels may form the pseudo-albuminous matter of struma.

Urea.—An excess of nitrogenous food will probably produce excess in the blood; a considerable increase taking place in the urine after such food.

From this triple source the blood becomes contaminated, unless the product of mal-assimilation in the stomach and duodenum is evacuated as fæcal, indigested food.

Phosphates.—An excess of phosphates in the blood will result from an undue proportion of *food* containing them. A vegetable diet has this effect, of which the experimental observations of Dr. Bence Jones* afford ample proof. Alkalies, taken continuously, favour the production of phosphates, by supplying the base with which phosphoric acid may combine.

Oxalic acid is occasionally introduced by particular kinds of food—*e.g.*, common rhubarb, sorrel, &c.; and then, if *hard* water, which contains lime, be drunk, oxalate of lime is formed in the blood. But

* "Animal Chemistry," &c.

this acid is more frequently generated by mal-assimilation of saccharine matters during the digestive process, as was first suggested by Prout.

Sulphuric acid, partly derived from the sulphates of the food, whether vegetable or animal, and from the oxidation of sulphur in its course through the body, may introduce or produce an excess, when either mode of food-origin is increased beyond the requirements of the system.

Hippuric acid, in excess, may arise from food itself too rich in carbon, *i.e.*, vegetable, as compared with animal food. Medicines containing benzoic acid have a similar effect, this acid being converted into hippuric acid during its passage through the system.

Lactic acid, in excess, may also have a food-origin; sugar, or amylaceous matters, by their decomposition, producing lactic acid, and certain sour kinds of food, as sour milk, or cabbage, having already undergone such decomposition.

Chlorides of sodium and potassium are introduced in excess, by articles of food abounding in these salts, *e.g.*, salted provisions.

Sugar.—Prout first suggested the possibility of sugar being a product of the primary *mal*-assimilation of farinaceous matters, and thence the origin of diabetes mellitus. It is well known that starch and gum are converted into sugar by the action of acids, and equally indisputable that the stomach is prone to

acidity in diabetes—a clinical fact which accords with the view advanced by the authority referred to. But the actual production of sugar during digestion in diabetes has been established by M'Gregor.*

Claude Bernard has since apparently demonstrated the constant production of sugar, alike from azotised and unazotised matters, by the liver, in health, and therefore the probability that this organ is at least one source of sugar in diabetes, by over-activity of its function, in respect of sugar-production.

Certain it is that sugar abounds in the blood of diabetic patients, as shown by the analyses of Maitland and Ambrosiani.

Oleaginous matters are probably generated freely by primary mal-assimilation in persons who have a marked tendency to obesity, and thence the blood becomes surcharged with fat. This excess not being relieved by secondary assimilation, it accumulates in the body, encompassing and invading the textures interstitially; and, in the process of nutrition, usurping and occupying the place of their proper structural elements, it becomes apparently one mode of fatty degeneration—by the substitution of fat; yet the blood remains surcharged from its original source of continued production.

All the foregoing conditions of urine have reference to those blood-diseases which result either from per-

* "Medical Gazette," 1837.

versions of nutrition, or of the functions of the digestive organs, or from both ; and which manifest themselves by these morbid states of the urinary excretion, they being in their turn signs of the existing blood-disease. The kidneys are merely the channels through which the noxious matter, whatever it be, is excreted from the blood.

(2.) *Mal-Excretion (a) through Kidneys*.—The kidneys are liable to undergo certain structural changes, whereby some one or more of the urinary constituents ordinarily excreted is retained in the blood, and thus adding a noxious matter thereto, gives rise to its own peculiar blood-disease. In any such case the morbid state of the urinary excretion is the sign of that structural change which the kidneys are undergoing or have already undergone. These organs, and the blood-disease induced, stand in the relation of cause and effect, while the peculiar state of the urine is the sign of the particular cause in operation. I allude chiefly to congestion of the kidneys causing suppression of urine, and to their fatty and granular degeneration—Bright's disease, originating a certain blood-disease by the retention of urea and excretion of albumen, as manifested by corresponding changes in the urine secreted—viz., the absence or diminished proportion of urea and water, and the presence of albumen in variable quantity.

All these changes are reflected in the blood. Analysis

discovers a large accumulation of water—tending to dropsical effusions, the retention of urea, and a diminished proportion of albumen, together with a rapid decrease of the red particles of the blood. “I am acquainted,” writes Sir Robert Christison, “with no natural disease, at least of a chronic nature, which so closely approaches hæmorrhage in its power of impoverishing the red particles of the blood.”

No other very marked changes occur. Subjoined are the results of Franz Simon’s observations as quoted by Dr. Owen Rees.*

	Water.	Blood Fibrin.	Corpuscles.	Solids of Serum.
Health . . .	775·7	3·8	137·1	83·4
Albuminuria .	808·3	3·9	133·9	54·8 (1)
	859·2	8·2	75·5	57·2 (2)
	855·5	4·5	42·7	97·3 (3)

(1.) A man aged 55.—First stage of granulation, anasarca: urea in blood.

(2.) A man aged 44.—First stage, more advanced than (1) anasarca, pneumonia: urea in blood.

(3.) A man aged 23.—Advanced granulation, after scarlatina.

(b) *Skin-Excretion*.—Turning from this to other excretions, considered with regard to the etiology of blood-diseases—the *sweat* being complementary to the excretion of urine, comes next in order. While, however, much is

* “Nature and Treatment of Diseases of the Kidney, connected with Albuminous Urine, Morbus Brightii.” 1850.

known respecting the structure and functions of the sudoriparous glands, chiefly by the researches of Purkinje, Breschet, and Roussel de Vauzeme, little can be said specially respecting this glandular system in its causative relation to morbid conditions of the blood; thus affording another proof, if more be necessary, of the incompetency of Physiology to predetermine anything in Pathology. The latter must be founded on independent observation; and in respect of the sudoriparous glands, their pathology has not yet been separately investigated. *Arrest* of the function of these glands—checked perspiration—has hitherto been observed only in connection with febrile diseases; “but,” remarks Erasmus Wilson,* “it is probable that the perspiratory secretion, like that of other secerning glands, may be diminished and checked, as a consequence of inflammatory disorder of the sudoriparous glands themselves, independently of the rest of the organism. Dryness of the skin, occasionally met with, is owing to the absence of secretion by the sebiparous or sebaceous glands.”

Arrest of the perspiratory secretion must obviously induce some morbid condition of the blood, by retention of the *excrementitious* matters which should be eliminated. Rheumatism is usually attributed to this cause, under the influence of exposure to wet and cold.

* “Diseases of the Skin,” ed. 4, 1857.

The perspiratory secretion of certain parts of the body—*e.g.*, the axillæ and feet—is apparently specially excrementitious; and the sudden suppression of rank sweat therefrom has been followed by typhoid symptoms of the worst character, obviously due to retention of poisonous matter in the blood.

Certain constituents of the *urine* and *bile*—*e.g.*, lithic acid and bilin respectively—may be detected in the perspiration occasionally, and then the blood is assuredly poisoned. Besides, however, being *complementary* to other excreting organs, it would appear that the skin, in common with all such organs, eliminates *many other* matters, which are either of a poisonous nature, or, if innocent, have accumulated in excess; and which, in either case, had been *taken* into the circulation. The following substances have been detected in the sweat:—Quinine, sulphur, mercury, iodine, iodide of potassium, assafœtida, garlic, saffron, olive oil, rhubarb, indigo, Prussian blue, and copper.* Suppressed elimination of these matters will cause morbid conditions of the blood, severally varying in importance with the particular matter retained. The perspiration has been known to undergo certain inexplicable alterations of *colour*, becoming blue, green, saffron, yellow, ruby, or black; and unless these changes are due to colouring matters only, they bespeak some more serious pervers-

* "General Pathology," Stark, p. 1127.—"Elements of Physiology and Therapeutics," Baumgärtner, p. 486.

sions of excretion, which, if checked, will inevitably be reflected in the blood.

The sweat sometimes becomes altered in another sense. Instead of being excrementitious, it may carry off some one or more of the *essential* constituents of the blood, which is thus robbed of what should be retained. For example, albumen has been found in the sweat in rheumatic fever, gastric, putrid, and hectic diseases, and on the approach of death.* Or, some essential constituent of the blood, and one that is also a normal constituent of the sweat, may be secreted in *excess*, affecting the blood's healthy composition and properties, by altering the *proportion* of its essential constituents. For example, an undue quantity of sweat is sometimes secreted in very hot weather, thereby draining off from the blood an excessive quantity of *water*. This disorder, known as idrosis, was witnessed by E. Wilson in several instances, during the burning August of 1856; and a similar condition was a prominent feature of the "sweating sickness" that occurred in England in the sixteenth century.

Possibly idrosis should be regarded as an excessive secretion of more than water; that *all* the constituents of sweat—which, as a whole, is properly excrementitious—are simultaneously eliminated only in undue quantity; nevertheless, the blood's composition becomes altered, relatively to the *proportion* of *other* excremen-

* Op. cit. Wilson.

titious matters passing into the circulation. The *balance* of *effete* matters of various kinds, ever mingling in the blood, is disturbed; and whatever relatively preponderates will represent a blood-disease, enduring until such balance is readjusted by a compensatory discharge of other excretions of an opposite character. This view of idrosis, and its relation to the blood's constitution, implies a pathological principle, well illustrated by the consequences of an excessive discharge of *other* excretions. Bilious flux, for example, as compared with a diminished proportion of urine excreted, gives rise to a constitutional disturbance, which, agreeably to the principle alluded to, is thus interpreted by Dr. C. J. B. Williams: *—Urine contains a large proportion of azote; its excessive separation from the blood, therefore, leaves a comparative predominance of hydrogen and carbon in this fluid. Bile, again, abounds in hydrocarbon, and its copious removal, therefore, leaves a superfluity of azote. Accordingly, a flux of bile is either accompanied by a highly loaded state of the urine, or by fever, not subsiding until the urine becomes very copious, or deposits an abundant sediment. The most probable interpretation of this fact is, that excessive secretion of bile disorders the composition of the blood: so long as the kidneys rectify this disorder, by separating in greater abundance the solid contents of the urine, no fever results; but if the kidneys fail in their

* "Principles of Medicine," 1856, pp. 131, 132.

task, fever ensues and continues until they resume it; then a free secretion from them, and copious urinary deposit, is symptomatic that the fever is declining.

(c) *Liver Excretion*.—Contrasting with the blood-disease consequent on *bilious flux*, an opposite state of the blood, signified by jaundice, is the offspring of a continued *deficient* elimination of bile from the system. This occurs in either of two ways: by some mechanical impediment to the free escape of bile through the ducts into the duodenum, or by the suppression of bile-secretion. The structural conditions will be hereafter noticed in connexion with the Symptoms and Treatment; but in either case jaundice arises.

MORBID CONDITIONS OF THE URINE.—Having briefly traced the general pathology of the blood, so far as it is a primary part of urinary pathology, we proceed to examine the accompanying morbid conditions of the urine. They are the immediate causes of irritability of the bladder, and their diagnostic interpretation is essential to the removal of those conditions of the blood, of which they are also but the symptomatic manifestations.

Each such (symptomatic) condition of urine will be preceded by a tabulated view of the several diseases with which it will be found, according to our present experience, to be associated. In none of the diseases thus indicated, is the particular state of urine *invariably* present in every case, nor through the whole course of the disease; nor is the *amount* of increase or diminu-

tion expressed. But, allowing for these unavoidable omissions, this arrangement will be convenient for ready reference in respect to the several conditions of urine described.

Urine for Examination.—The diagnostic interpretation of any particular state of urine obviously has reference to its source or origin in the system. The *products* arising and accruing from mal-assimilation—whether by that of digestion (primarily) or of nutrition (secondarily)—and which appear in the urine, can be selected for examination by observing a very simple precaution with regard to the sample of urine.

Urine secreted at from three to six hours after a meal presents the products of digestion, while that secreted several hours subsequently, when the urine from this source has run off, presents the products of nutrition in its destructive metamorphosis, or the *débris* of the textures. The latter may be called *urine of the blood*; and if examined in the morning before breakfast, after an interval of fasting from over-night, will be found to contain, unlike the *urine of digestion*, the waste of the textures. To make this observation complete, the bladder should be emptied over-night, to preclude any admixture of the urine then in the bladder with that which is secreted during the night. By this precaution, the products from these two sources of urine can be detected and distinguished, in most cases, with approximate certainty.

Changes in Urine from Decomposition, after Emission.

—*Stale Urine*.—The changes which take place in the urine after emission, and as the result of decomposition, must not be mistaken for those which represent morbid conditions.

Healthy urine may thus undergo departures from its ordinary slightly acid reaction, in two opposite directions; becoming *highly acid*, or turning to an *alkaline* condition.

(a) *Hyper-acidity, or Acid Urinary Fermentation* (Scherer).—This change consists in the generation of lactic acid and acetic acid; the mucus of the bladder acting apparently as a ferment on the urinary pigment. Like other fermentive processes, therefore, this one is prevented or arrested by alcohol or boiling, or by removing the ferment—vesical mucus by filtration. The changes consequent on this production of acidity are, a precipitation of the amorphous urates, then of uric acid, and often of oxalate of lime. Simultaneously, confervoid vegetations—the mould or sugar fungus—are apt to appear. Acidity, increasing for some five or ten days, declines as putrefaction succeeds. An ammoniacal reaction and odour now supervene, with opacity of the urine from the development of myriads of minute linear particles—vibrios. The amorphous urate deposit has become changed into dark round masses of urate of ammonia, uric acid crystals are replaced by bright prisms of triple phosphate, and amorphous phosphate of lime sinks as an abundant

sediment. The growth of confervoid vegetations is arrested with the change of reaction, and they perish as putrefaction is established. Exceptions to this order of change occur. Urines of low acidity or of low specific gravity do not undergo any marked increase of acidity; but they become ammoniacal in a day or two, or possibly in a few hours.

(b) *Alkalescence*, in exposed urine, results from the transformation of urea into carbonate of ammonia, and this change may be induced by contact with any decomposing matter, stale urine in particular.

(c) Certain *organic deposits*, as blood corpuscles, renal epithelium, and uriniferous tubule casts, are soon destroyed by an exposure of twelve or twenty-four hours, especially in urine of low specific gravity. But pus corpuscles, scaly epithelium, and spermatozoa, retain their microscopical characters for a much longer period, even to an advanced state of urinary putrefaction.

Bearing in mind all these peculiarities of decomposed urine, the rule should be to examine any specimen of urine within a few hours after its emission.

Clinical Examination of the Urine.—From a practical point of view, an examination of the urine is a much more simple procedure than that whereby original investigations are conducted, as commonly detailed in works on Urinary Pathology, but which necessarily involves a minute knowledge of chemical analysis and of microscopic manipulation beyond the requirements

of clinical practice, or the time at command of those who are so engaged.

The following *method of examination* represents the order of procedure which will commonly be found sufficient, and the essential particulars to be noted with reference to morbid conditions of the urine, in ordinary cases.

(1.) *Physical Characters*.—Observe colour, clearness or turbidity, any deposit or foreign body, odour, reaction—acid, alkaline, or neutral, as tested by a slip of litmus paper, specific gravity.

A deposit—observe its colour, admixture with, or separation from, the urine, and whether floating on the surface as a pellicle, suspended as a cloud, or precipitated as a sediment, apparently amorphous or crystalline.

(2.) *Chemical Tests*—(a) for Deposits, Effect of *heat*.—Pour a sample of the urine, with deposit, if present, into a test-tube, and over the flame of a spirit-lamp heat gradually to ebullition. Observe disappearance of turbidity, as when a deposit of *lithates*; or appearance of turbidity, as by a deposition of *phosphates*. Or the latter appearance may be the coagulation of *albumen*. Drop a few drops of *strong nitric acid* into the tube, and heat again; the one deposit, phosphates, entirely disappears, the other, albumen, becomes increased and consolidated.

Other tests for deposits: solubility in acetic acid, in liquor potassæ; insolubility in both acids and alkalies.

An approximate estimate of the whole quantity of lithic acid, or of phosphoric acid, excreted, beyond what is indicated by any deposit, should then be determined.

(b.) For Foreign Constituents.—Albumen, its absence or presence; and approximate calculation, from the quantity in a given measure of urine, of the whole quantity passed in twenty-four hours.

Sugar, its absence or presence; and similar approximate calculation of quantity.

Bile, its absence or presence.

(3.) *Microscopic Examination*.—Crystals, absence or presence in urine, or in any deposit; their shape, or other characters. Blood corpuscles, pus and mucus corpuscles, epithelial cells, uriniferous tubule casts, spermatozoa. Vegetable parasitic productions, or as engendered in decomposing or fermenting urine, *e.g.*, penicillium glaucum in non-saccharine urine; torulæ cerevisiæ, yeast-plant, in saccharine urine, when subjected to the fermentation test. Other foreign substances, *e.g.*, hairs, cotton fibres, from towel used in examination, sputa, starch granules from admixture of food or tooth-powder, faecal matter, particles of soot, sand, or dirt.

Appliances for Examination of Urine.—(1.) *Chemical*. Certain simple chemical apparatus and tests will suffice for a clinical examination of the urine, and of its deposits.

The *apparatus* comprises—Urine glasses, rather tall and deep receptacles suitable for immersion of the urinometer in taking the specific gravity of urine, and one glass being graduated as a measure; test-tubes, in a half-dozen series, with urinometer-stand, spirit-lamp, and well corked bottle of methylated spirit, slips or slides of glass, drop-tubes, and glass stirring rods.

The *Tests* ordinarily required are—Acids: nitric acid fort., acetic acid. Alkalies: Liquor potassæ, liquor ammoniæ fort. *Special tests*: Sulphate of copper solution, or blue hydrated oxide of copper, or yeast for sugar-testing; sulphuric acid for bile testing.

(2.) *Clinical Microscope*.—Oberhauser's microscope is an instrument which I have been accustomed to use for many years in the examination of the urine and its deposits. I have had the same instrument in use since the year 1853, a period of eighteen years. The only inconveniences I have experienced in working it are, that in altering the focus, or the field of vision, respectively, the requisite adjustment cannot be so readily commanded by the hand-movement of the tube, or the object, as it is by the screw-movements in other microscopes. But, unprovided with this, additional mechanism for either such purpose, the price of the instrument is much less, an important consideration with regard to its general eligibility.*

* Oberhauser's Microscope and Object-glasses, &c., with Box. complete, £6.

Beale's clinical pocket microscope is a very simple, portable, and inexpensive instrument.

Object-glasses required for Clinical Examination.—Whatever form of microscope be preferred, the object-glasses, for magnifying the object to be examined, are the most essential requisite. The qualities of an object-glass consist in its magnifying power and achromatic character, by clearly defining the object, without any encircling play of colours. The powers most commonly useful in medical practice are two—the *quarter of an inch* focus, magnifying about 200 diameters, and the *inch*, magnifying about 30 to 50 diameters.

Microscope Lamp.—For examining objects by artificial light at night, or otherwise in the absence of daylight, some kind of illuminating contrivance will be necessary. An ordinary French lamp, provided with a blue glass chimney, may be used, or that recommended by Dr. Lionel Beale, a small paraffine lamp, with a round wick, may be preferred. But in the absence of any such lamp, a short wax candle, giving a clear white light, steadied by a screen, supplies a ready contrivance which will generally suffice.

*Lithic or Uric Acid ($C_{10}H_4N_4O_6$) in Urine.**Diseases associated :—*

Increased with	Diminished with
Dyspepsia.	Anæmia and chlorosis.
Gout.	Diabetes mellitus.
Nephritis, acute.	Nephritis, chronic.
Rheumatic fever.	
Disease of liver.	
Cirrhosis.	
Jaundice.	
Chronic diseases of stomach.	
Enlargement of spleen ?	
Ague.	
Leucocythemia.	
Pneumonia.	
Phthisis pulmonalis, acute.	
Ditto	chronic ?
Emphysema of lung.	
Ditto, with bronchitis.	
Capillary bronchitis, acute.	
Pleurisy.	
Disease of heart.	
Typhus fever.	
Typhoid „	
Scarlet „	
Small-pox.	

Increased with

Eczema impetiginodes, acute.

Epilepsy ?

Chronic diseases ?

General Symptoms.—They are those of gout, which may be taken as representing the lithic acid diathesis.

The premonitory symptoms refer to the digestive organs more especially, but also to the heart, lungs, brain, and perhaps other viscera. Dyspepsia, denoted by heartburn, eructations, acidity of the saliva, inappetency, and nausea. The bowels, distended with flatus, are irregular—urgent diarrhœa alternating with constipation. Pains dart about the body, and, with general restlessness and peevishness, there is much depression of spirits and gloomy apprehensiveness. Palpitations and shortness of breath evince the sympathy of the thoracic organs; while headache, with a swimming sensation, and sometimes a feeling of explosive fulness, are the accompanying cerebral symptoms.

A *fit* of the gout is manifested by inflammation attacking the joints, and very commonly the first joint, or ball, of the great toe. Commencing usually when the person about to suffer has retired, and has, perhaps, enjoyed some hours of sleep, he is awoke with pain in one of the feet, affecting the ball of the great toe, or, it may be, the heel, instep, or ankle. Cold shivering generally takes place, succeeded by

heat, as the pain—boring, grinding, and wrenching—fastens more and more firmly on the spot of its choice. “Place your joint in a vice,” said a witty Frenchman, “and screw the instrument up until you can endure it no longer. That will represent rheumatism. Then give another twist, and you will somewhat realize gout.” The skin over this part is acutely tender, red, tense, and shining, encircled by some swelling and by converging turgid veins. Much restlessness and excitement supervene. In vain the sufferer seeks to relieve himself of the weight of his bed-clothes upon the part inflamed, in vain he shifts his foot from place to place in search of a cool and easy position. The pain, remorseless, grapples yet more tightly. At length, in the course of twenty-four hours or so, it loosens its hold gradually, perhaps suddenly. The sleepless excitement also then subsides, and the victim enjoys some temporary repose. He wakes again to undergo punishment. The toe-screw is re-applied, it may be with a turn or two less; and daily a slighter punishment is inflicted, until at length the full penalty has been paid. Then the cuticle peels off the part, for gouty inflammation ends in resolution, it never terminates by the effusion of lymph, suppuration, or gangrene.

Sometimes, having settled in the foot, it suddenly disappears, and migrates to the stomach—though this has been denied—to the heart or brain; *retrocedent* gout,

as it is then called, being, unlike the retreat of an ordinary foe, an assault on the very fortress of life. Less perilous migrations occur; to the urethra, with a scalding discharge; to the testicle, a form of orchitis; to the eye, inducing ophthalmia.

The real decline of an attack is marked and measured by a flow of urine, surcharged with lithic acid, thus relieving its accumulation in the blood, and plainly declaring the nature of the disease. Irritability of the bladder at this time is often tormenting. Repeated attacks of gouty inflammation leave structural results behind; the cellular texture around a joint becomes pervaded with a deposit of lithate of soda, forming concretions, at first pultaceous, then chalk-stones of perhaps considerable size. Hence the nodular toes and fingers of *chronic* gout. The skin over these nodules being stretched, at length breaks, and the chalky concretions are laid bare. Lithate of soda has been found infiltrating all the textures of one or several joints; in the synovial membrane, cartilage, heads of bone, and ligaments; and usurping their place, the articulations are irreparably destroyed.

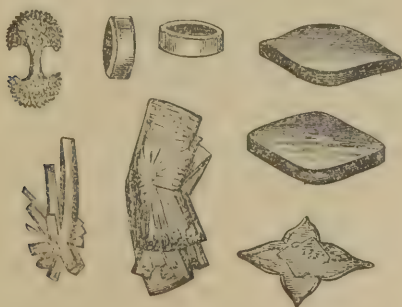
Physical Characters of Urine.—Clear, bright, golden or coppery colour, like brown sherry. Specific gravity increased. Quantity somewhat diminished. Acid reaction more decided, producing a deeper shade of red in blue litmus paper. A deposit of yellow or red

sand, resembling particles of cayenne pepper,—lithic acid, sometimes in great abundance.

Diagnostic Value.—Lithic acid is eliminated from the blood, in combination with some base—soda, or ammonia more commonly, forming lithates of soda and ammonia. These salts, readily soluble in urine of the temperature of the body, are precipitated only when present in excess proportionately to the aqueous portion of urine secreted, and as the supersaturated solution cools. They then appear as yellowish, or red brick-dust deposits, which will be presently described. Lithic acid may, however, be liberated from these salts, by decomposition; but it occurs only when *some other* acid is present in *excess* to replace the acid in combination. Free lithic acid being insoluble, is then precipitated, appearing as a deposit in the urine having the above characters.

Microscopical Characters.—This deposit consists of

FIG. 1.



minute crystals, in various shapes, of which rhom-

boidal prisms are the most commonly characteristic. (Fig. 1.)

Respecting the kind of acid by which uric acid is thus deposited, Parkes observes:* “It does not follow that the acidity should be owing to any single acid; it is owing either to an augmentation of all the usual acids of the urine—the sulphuric, phosphoric, and perhaps the hippuric, the lactic, and the carbonic—so that the bases are insufficient to neutralise them—or to the formation of acids after emission of the urine—viz., probably the lactic, acetic, butyric, or oxalic.

“It is, of course, possible that the deposit of uric acid may be owing, not to excess of other acids, but to absolute deficiency of alkali: no facts have yet been discovered on this point.

“The two causes of increased acidity of the urine—excess of normal acids, and formation of acid after emission—are sometimes in simultaneous action. The urine depositing lithic acid without lithates is not usually the high-coloured, red, pigment-loaded urine, but yellow and transparent; the acid is deposited slowly, and without admixture with lithates. Uroxanthin (indican) is often present in large quantity; and, as Virchow suggests, it may more rapidly form acid than common pigment.”

The practical issue of all these considerations is this—

* “Composition of the Urine, in Health and Disease, and under the action of Remedies,” 1860, p. 218.

that to rightly estimate the value of "lithic acid urine," as the sign of a corresponding "morbid blood-condition," it is necessary to discover the *total* amount of lithic acid excreted from time to time; and for this purpose we cannot trust any *deposit* thereof, either combined or free. The lithates may be in excess, *short* of a supersaturated solution; and lithic acid itself becomes apparent only when the urine is hyperacid from *other* causes.

Chemical Tests.—The over-acid reaction, as shown by blue litmus paper, has already been noticed.

A *deposit* of uric acid is insoluble in hot water, but soluble in alkalies—potash, soda, and ammonia.

A portion of the deposit is to be dissolved in a drop of potash. The alkaline solution is then to be treated with excess of acetic acid. In a few hours, crystals of uric acid will have formed, which can be identified by microscopic examination.

A portion of the deposit may be placed on a glass slide, and treated with a drop of strong nitric acid. Evaporate to dryness by a gentle heat, and expose the slide to the vapour of ammonia, or add a drop. . A beautiful violet colour, from the formation of murexide, attests the presence of uric acid, or a urate. (L. Beale.)

The *total amount* of lithic acid excreted can be discovered by a simple experiment, devised by Golding Bird. Let all the urine passed in twenty-four hours

be collected, well shaken, and a given quantity—say about two ounces—be mixed in a conical glass vessel, with about half a drachm of hydrochloric acid. In six or eight hours crystals of uric acid are copiously deposited on the sides of the glass. To ensure their complete separation, they should be allowed to repose for twenty-four hours, and may then be washed, dried, and weighed.* Simple multiplication shows the whole amount of uric acid secreted in the twenty-four hours, without the chance of any considerable error. In estimating the pathological importance of the result thus obtained, the healthy standard of quantity should be remembered, and this ranges from 6 to 10 grains of uric acid in twenty-four hours.

Urates or Lithates of Soda or Ammonia in Urine.

Diseases associated:—

The same diseases as with Lithic Acid Urine.

Physical Characters of Urine.—Turbid in all cases on cooling and depositing lithates; the other characters are apparently in unison, principally, with their colour. *White* lithates are deposited from a pale-coloured urine; specific gravity low; 1·010 to 1·014. The deposit is suspended, having a whitish flocculent cloudy appearance, which resembles mucus. *Fawn*-coloured lithates are deposited from an amber-coloured urine; specific gravity higher, but still lower than

* "Urinary Deposits," ed. 4, 1853. See also "Animal Chemistry," &c., by Bence Jones, 1850, p. 53.

normal, being about 1.018. *Red* brick-dust lithates are deposited from a yet deeper-coloured urine, and of higher specific gravity. *Purple* and *pink* lithates are deposited from a corresponding coloured urine, and of high specific gravity. The quantity of lithates secreted, and precipitated spontaneously, may not be equal. Hence the latter may not indicate the *whole* quantity. They are held in solution by urine of the ordinary temperature of the body, 98°; but as the urine cools on exposure in the vessel used for its reception, the lithates are deposited. The proportion of water, as a constituent of urine, will also regulate the quantity deposited. These two conditions have been already noticed. But over-acidity of urine, owing to other acids in excess, allows an abundant deposit; whereas, a slightly acid or alkaline urine holds a proportion of the lithates in solution.

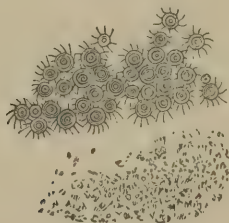
Microscopical Characters. — Amorphous granules is the usual appearance of lithates, as seen under the microscope; but certain forms of crystal are, occasionally, presented. Thus, spherules, sometimes constricted in the middle, assuming a dumb-bell shape, or spherules with little claw-like projections. (Fig. 2.) The junction of lithic-acid crystals gives rise to various singular appearances.

Chemical Tests.—Heat re-dissolves the lithates. Hot, not to say boiling, water poured into the chamber-utensil, causes the turbidity to disappear, and thus clears

the urine. But this result may be partly due to the increased proportion of solvent, water, thus added to a previously concentrated urine. A small quantity of the turbid urine heated in a test-tube becomes clear, but it again becomes turbid on cooling. The deeper-coloured urates are dissolved by a rather higher temperature than the paler varieties. Alkalies—potash, or ammonia, dissolve these deposits; acids—hydrochloric or acetic, separate uric acid, having the appearance and crystalline forms already described.

A rough approximate analysis of the urates may be readily accomplished. The uric acid having been determined in a weighed portion of the dried urate by dilute hydrochloric acid, another portion of the urate should be burnt, and, after washing the ash, tested with the blow-pipe. If the base be ammonia, a very small quantity of

FIG. 2.



ash only will remain. For a full analysis of the urates, they should be previously examined with the microscope to ascertain whether they are free from phosphate of lime or magnesia, or oxalate of lime (Hassall).

Potash may be the most abundant base, next ammonia, and last soda. (Bence Jones.) *Lime* is always present in considerable quantity. (Hassall and Scherer.) *Magnesia* is an occasional base. (Robin and Verdeil.)

It would, therefore, appear that the term *mixed* urates more accurately designates this deposit. The proportion of uric acid is always large—over 80 per cent. (Scherer) ; over 90 per cent. (Bence Jones).

Urea ($C_2H_4N_2O_2$) in *Urine*.

Diseases associated :—

Increased with	Diminished with
Acute pneumonia.	Epilepsy.
„ phthisis.	Acute yellow atrophy of liver.
„ capillary bronchitis.	Spasmodic asthma.
Pleurisy.	
Acute hepatitis.	Non-febrile icterus.
Rheumatic fever	Acute gout.
Meningitis.	
Typhus fever.	
Typhoid „	
Scarlet „	
Measles.	
Small-pox.	
Diabetes mellitus.	Diabetes insipidus.
Diuresis after dropsy.	

Increased with	Diminished with
Nephritis, acute.	Nephritis, acute and chronic.
Ague, during fit.	Ague, after fit.
Acute eczema?	

General Symptoms—are those of great muscular weakness and nervous exhaustion, with sometimes a dull aching pain across the loins; a worn, anxious expression; and, with diuresis, pallid emaciation, craving hunger and thirst. Irritability of the bladder is a marked symptom in all cases.

Physical Characters of Urine.—Excess of urea may occur, without diuresis,—the quantity of urine seldom exceeding the normal quantity, but the quantity of urea being both absolutely and relatively greater than in health; or with diuresis,—the quantity of urine being excessive, and the quantity of urea, therefore, in a given specimen, less than in health, but the quantity, absolutely, and relatively to the other constituents, greater also, in this case, than normal. *Asoturia*, or ureal diabetes, as the latter may be termed, although differing only in degree, is a very rare disease.

The former condition of urine is, in colour, clear and pale, but occasionally assuming the appearance of porter diluted with water; odour, not peculiar, but ammoniacal (apparently from decomposition of the urea) when not quite fresh; specific gravity rather above the average, 1.020, but varying from 1.015 to

1.030, or even higher. Quantity about normal. Reaction acid, when the urine is fresh, but speedily becomes alkaline, from ammonia. A deposit of urea, in crystals, soon forms by evaporation, on the addition of nitric acid, forming the nitrate of urea.

Microscopical Characters.—Long needle-shaped crystals, by evaporating a drop or two of urine on a slip of glass. Nitrate and oxalate of urea also present

FIG. 3.



crystals; the former in hexagonal plates and rhombic octohedræ (Fig. 3); the latter, in rectangular and right rhombic prisms, with a tendency to the formation of dumb-bell shaped oxalate of urea.

Chemical Tests.—Nitric acid added to a few drops of urine on a slip of glass, forms the nitrate of urea ($\text{C}_2\text{H}_4\text{N}_2\text{O}_2, \text{HO}, \text{NO}_5$), which, on evaporation, appears as a crust, more or less thick, according to the *quantity* of urea. Oxalate of urea ($\text{C}_2\text{H}_4\text{N}_2\text{O}_2, \text{HO}, \text{C}_2\text{O}_3$) is formed in like manner. Either compound can be verified by microscopical examination, while the chemical test indicates, approximately, the *quantity* of urea present.

Other tests are described in special works, but the

above is the most ready method of detecting and determining urea.

*The separation of urea, in a free state, may be obtained from either the nitrate or oxalate, by the following simple process:—*Dissolve the oxalate of urea, for example, in hot water, and treat the solution with carbonate of lime, until effervescence ceases; the oxalate of lime thus formed, and any excess of the carbonate, are precipitated, leaving the urea in solution. Carbonate of baryta may be used instead of the lime salt. Nitrate of urea may be decomposed in like manner. Crystals of nitrate of baryta are thrown down; the fluid is to be filtered, evaporated, and the residue extracted with ether.

Distinctive Characters of Urate of Soda, Earthy Phosphate, and Pus.—These three deposits are very similar in appearance, but have widely different pathological significance. Their certain and easy distinction is therefore of great practical importance. The following simple method of examination, and distinctive characters, are given by Dr. Lionel Beale.

Let the urine stand in a conical glass for some time. Then pour off the clear supernatant fluid, and transfer a small portion of the deposit into a test-tube. Add about half the bulk of solution of potash, and observe:—

1. If urate of soda and ammonia, the potash may cause the mixture to become *clear*, but not viscid.

2. If entirely phosphate, *no change* will be produced.
3. If pus deposit, the mixture will become *clear*, and very *stringy* or viscid.
4. If both pus and phosphate be present, the mixture gelatinises, but does not become clear.

Microscopic examination will confirm this chemical test.

Phosphates in Urine.

Amorphous phosphate of lime—bone-earth ($3\text{CaO}, \text{PO}_5$).

Crystallised phosphate of lime ($2\text{CaO}, \text{HO}, \text{PO}_5 + 3\text{HO}$).

Phosphate of ammonia and magnesia—triple phosphate ($\text{NH}_4\text{O}, 2\text{MgO}, \text{PO}_5 + 12\text{HO}$).

Phosphate of soda ($2\text{NaO}, \text{HO}, \text{PO}_5 + 24\text{HO}$).

Acid phosphate of soda ($\text{NaO}, 2\text{HO}, \text{PO}_5 + 2\text{HO}$.)

Diseases associated :—

Increased with	Diminished with
Meningitis.	Delirium tremens.
Acute mania, during parox.	Acute mania, in exhaustion.
Acute dementia, during parox.	Acute dementia, in exhaustion.
Rickets.	Paralysis of insane, third stage.
Mollities ossium.	Acute gout.
Acute rheumatism.	Acute rheumatism.
Cholera early.	Cholera later.

Increased with
Chronic phthisis?

Diminished with
Pneumonia.
Bright's disease, acute and
chronic.
Typhus abdominalis.
Pleurisy, acute?
Ague?
Diabetes?

General Symptoms—consequent on an excess of phosphoric acid in the system, are those of exhaustion with irritability. Depression of spirits with irritability of temper; muscular weakness, and aching pains, especially across the loins, with perhaps a flickering endeavour to shake off debility, for such persons are not unfrequently intellectually active and energetic beyond their strength; these symptoms, with atonic flatulent dyspepsia, and sallow emaciation, as if consumption were in progress, complete the picture of the phosphatic diathesis. Irritability of the bladder is frequently very distressing.

Physical Characters of Urine.—Turbid in all cases, on depositing phosphates; of a pale yellow colour, if the deposition be occasioned by fixed alkali—potash or soda, and of an orange-brown colour, if occasioned by carbonate of ammonia—volatile alkali; the odour is ammoniacal, in the latter case; while the specific gravity varies greatly with the colour—the pale urine having a low specific gravity, the higher-coloured, a

high specific gravity. The quantity is increased generally. The reaction varies—being alkaline or neutral, or slightly acid when first evacuated. The deposit of phosphates appears as a white sand, but generally combined with mucus, often present in large quantity, and pus, probably, in variable quantity.

Diagnostic Value.—Phosphatic urine, as ordinarily estimated by the amount of phosphates *deposited* in the urine, is deceptive. Phosphatic urine, in this sense, is only an appearance, not a true measure of the whole amount of phosphates present, and of the pre-existing blood-condition.

The pathological significance of phosphatic deposits in the urine has been investigated more particularly by Dr. Bence Jones.

Of *all* the phosphates *present*, not necessarily deposited, in the urine, those of soda are most abundant; equaling in amount three or four parts of the whole. The earthy phosphates of lime and magnesia represent the remainder. Phosphatic urine, therefore, should rather, of the two, have reference to the former salts. But the phosphates of soda are so very soluble in water and in acid or alkaline urine, that they are never deposited. In this respect resembling the sulphates of potash or soda, any excess of these phosphates remains concealed. On the contrary, the phosphates of lime and magnesia are scarcely soluble in water, and nearly insoluble in alkalis, although very soluble

in acids, even in acid phosphate of soda. Therefore, whenever the urine becomes alkaline, down go the phosphates of lime and magnesia. This precipitate, however, denotes only the quantity of lime and magnesia drawn from the blood, and now appearing in the urine. The *major* portion of *phosphoric acid*, being combined with soda, remains unobserved.

By taking more lime or magnesia in the food, or by adding these bases to the urine, we increase the amount of earthy phosphates; and by a sufficiency we precipitate *all* the phosphoric acid in combination with *them*, thus leaving no *phosphate* of soda in solution. Conversely, if we could abstract all the lime and magnesia, no precipitate would appear by adding alkalies—in which, as well as acids, phosphate of soda is soluble,—though there remained a great excess of phosphate of soda concealed in solution. But if lime and magnesia are present, as usual, in the urine, a portion of the phosphoric acid appears in combination with them, forming a deposit of *these* phosphatic salts whenever the urine becomes *alkaline*, in which they are insoluble. Hence the more appropriate name, *alkaline* urine, suggested by Dr. Bence Jones, rather than phosphatic urine, as ordinarily understood, which represents merely the amount of lime and magnesia present in combination with phosphoric acid. If regarded from this latter point of view, the term “phosphoric diathesis” should be extended to denote an in-

crease in the *total* amount of phosphates, *alkaline* and earthy; or, if limited to one phosphate, it ought to denote *alkaline* phosphate, it being proportionately four or five times more abundant than earthy phosphates in the urine; moreover, the term earthy diathesis, as indicated by the urine, if used at all, ought to signify urine which really contains an *excess* of lime and magnesia, and not the precipitation, it may be of only a small quantity, of these earthy salts, the urine having lost its healthy property of retaining them in solution on becoming alkaline.

In short, alkalescence of the urine and increase in the *total* amount of phosphates have no relation of any kind to each other. They are quite distinct, and, indeed, rather opposite states.

Microscopic Characters.—Supposing *alkalinity* of the urine be due to *fixed* alkali—as potash or soda—the phosphate of lime and the phosphate of magnesia are immediately deposited, appearing as a “white sand.” Submitted to microscopic examination, these salts are seen to consist of amorphous particles, or small round globules (Fig. 4), and, occasionally only, prismatic crystals with oblique or dihedral summits. According to Hassall’s observations,* crystallized phosphate of lime is common, much more so indeed than amorphous phosphate, which he regards as unusual.

* *Lancet*, 850, vol. i.; and “*Med.-Chir. Trans.*,” vol. xxxvi.

This white deposit and co-existing alkaline condition of the urine occur whenever an excess of fixed alkali, or, what is equivalent, a deficient proportion of acid, is taken in the food. The urine is *secreted* alkaline, and deposits its earthy phosphates in greater or less abundance, according to the quantity of lime and magnesia present.

Not to be misled by an alkaline condition of the urine from *fixed* alkali, it is most important to know and remember that the acidity of *healthy* urine varies considerably during the diurnal period. According to the observations of Dr. Bence Jones, confirmed by those of Dr. W. Roberts, it is *inversely* to the acidity of the stomach. During digestion, when some acid, probably the hydrochloric, is being secreted by the stomach, an equivalent amount of soda or potash, previously in combination, must remain as free alkali in the blood, rendering it proportionately more and more alkaline. Accordingly, the urine becomes less and less acid, and perhaps eventually decidedly alkaline. When acid ceases to flow into the stomach, and any superfluous portion which had been secreted is reabsorbed, the blood regains its former *average* degree of alkalescence; the urine also is secreted less and less alkalescent, and becoming acid, its acidity rises until the next meal, when the highest degree of acidity is attained. If no food be taken, this condition of urine remains stationary for about twelve hours; immediately after a meal,

its acidity again falls, and gradually approaches an alkaline reaction.* Examined at such time, alkalinity of urine might inadvertently be regarded as a morbid condition; but examination of another and another sample excreted some time after a meal, when the process of digestion is completed, corrects this suspicion; the urine thenceforth is found more and more acid prior to the next meal, when the alkaline retrogression supervenes.

This alternation of digestion, with approaching alkalescence of urine, and restoration of acidity on completion of digestion, invalidates the result of *any one* examination of the urine. A *mixed* sample of the whole amount of urine excreted during the twenty-four hours will give its average condition.

If *volatile* alkali—as carbonate of ammonia—be the occasion of alkaline urine, then the *deposit* consists of the ammoniaco-magnesian phosphate, together with some phosphate of lime; the former appearing in the form of transparent prismatic crystals, or of foliaceous, penniform, or stellar crystals (Fig. 4). The two latter are phosphate of lime.†

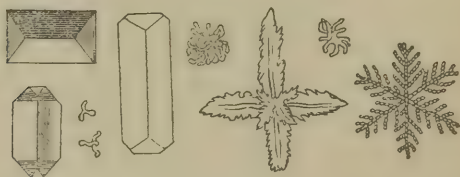
This deposit occurs whenever phosphates are deposited in connection with an inflamed state of the

* See adverse observations by Dr. Julius Vogel: "A Guide to the Analysis of the Urine," by C. Neubauer and J. Vogel, ed. 4. Translated for New Syd. Soc. by W. A. Markham, 1863, p. 296.

† *Lancet*, 1853, Hassall.

mucous membrane of the bladder, the ammonia being supplied by the decomposition of urea, which constituent of the urine may be regarded as carbonate of

FIG. 4.



ammonia, plus two atoms of water. Whether urine is ever *secreted* ammoniacal appears doubtful; without doubt, however, it may become so, after emission, by decomposition of the urea. This source of the ammonia present in the phosphate then formed was first clearly perceived by Lecanu, and has since been explicitly pointed out by Owen Rees. The decomposition of urea is effected apparently by the mucus, acting as a ferment, which is always more freely secreted by an inflamed mucous membrane, as in pyelitis and cystitis. Ammoniaco-magnesian phosphate, consisting of its characteristic crystals, is abundantly deposited; and equally so, a white tenacious substance, that can be drawn into skeins of considerable length. It is said to consist of pus-globules, they having become adherent under the action of ammoniacal urine. Thence the phosphate above mentioned, together with granules of phosphate of lime, are involved in one

gelatinous mass. This mixed deposit is frequently witnessed in cases of paralysis affecting the bladder, which then assumes a condition bordering on inflammation.

Chemical Tests.—All the phosphates are dissolved by acids—unlike coagulated albumen; and remain unaffected by heat—unlike the lithates; but the following points of contrast distinguish the two kinds of alkaline urine—the ammoniacal from that caused by fixed alkali.

Ammoniacal urine effects no change in blue litmus paper until it dries, when the pink colour immediately appears.* Urine becoming alkaline during digestion, *i.e.*, from *fixed* alkali, turns pink paper blue, which remains so when dry. *Ammoniacal* urine deposits crystals of phosphate of ammonia and magnesia, while urine otherwise alkaline, from *fixed* alkali, deposits an amorphous powder of phosphate of lime. The former deposit is associated with mucus and pus; the latter with mucus only, and rarely in great quantity. *Ammoniacal* urine is constantly alkaline; that from fixed alkali is only occasionally alkaline, *i.e.*, at particular periods of the day. *Ammoniacal* urine is a sign of local disease—inflammation of the urinary mucous membrane; whereas alkalescence from *fixed* alkali is a sign of a more general disorder, *i.e.*, indigestion.

Guided by these characters, we can detect and

* See "Trans. of the Chemical Society," vol. ii. p. 244, communication by Bence Jones.

discriminate the *kind* of alkali present in the urine, and its *source*. Yet such diagnosis, founded on the kind, and even the amount, of phosphatic salts *deposited* by the urine, signifies nothing concerning the *total* amount of phosphates *excreted from the blood*. The non-appearance of phosphates does not imply their absence, and their appearance is no measure of the total amount present. The question, therefore, an all-important one, presses, whether an *excess* of phosphates is accumulating in the "blood," consequent on some perversion of nutrition or digestion, and constituting the true "phosphoric diathesis?" Mere inspection of the urine may disclose nothing respecting this constitutional morbid condition; and should the urine be alkaline, we then discover merely the amount of earthy bases—lime and magnesia excreted in combination with phosphoric acid, and deposited. But this deposit of phosphatic salts contains only part of the whole phosphoric acid present. By far the greater portion remains concealed in the soluble phosphate of soda, which is never spontaneously precipitated under any circumstances.

To determine the *whole amount* of phosphoric acid eliminated, it is necessary to ascertain the amount of this alkaline phosphate, as well as that of the earthy phosphates. Both together represent the phosphoric diathesis.

For this purpose the following experimental process

is recommended by Bence Jones :—About 1,000 grains of urine are to be weighed, and the earthy phosphates precipitated by pure ammonia, free from carbonate. These should be filtered, washed with ammoniacal water, and heated to redness; adding at last a drop or two of nitric acid. The amount of earthy phosphates is determined by weighing the residue. The alkaline phosphates are estimated by taking about 500 grains of urine, adding an excess of chloride of calcium, and then pure ammonia. Thus all the phosphoric acid is precipitated as phosphate of lime. This is to be filtered, well washed, and the filter and the precipitate burnt with a drop or two of nitric acid. If the filtration has been slow, it is necessary to redissolve the residue in a platinum crucible by hydrochloric acid, and to re-precipitate by pure ammonia, when the filtration will take place very rapidly. After being burnt, the crucible is weighed, and by deducting the previously determined earthy phosphates, the difference may be taken as the amount of alkaline phosphate.*

Oxalate of Lime ($C_2O_3 + CaO + 2HO$) in *Urine*.

Diseases associated :—

Increased with

Dyspepsia.

Scrofula.

Gouty diathesis.

Rickets.

Uric acid and urates in urine. Emphysema of lung.

* See "Phil Trans.," 1845, p. 365.

	Increased with	
Cirrhosis of liver.	Emphysema	of lung with
Jaundice.	phthisis.	
Cholera, convalescence.	„	„ with bronchitis.
Bright's disease, chronic.	Spermatorrhœa.	
Convalescence from severe	Pregnancy.	
diseases.	Diabetes mellitus.	
Many chronic diseases.	Epilepsy.	

General Symptoms.—They are those of exhaustion with irritability. Depression of spirits, even to melancholy, with irritability of temper, often amounting to irascibility; great muscular debility, with a severe and constant pain or sense of weight across the loins; flatulent dyspepsia, well marked, and loss of flesh: all these symptoms corresponding very much to the phosphatic diathesis. But the deeper tinge, so to speak, of the symptoms referred to, and the peculiar olive-greenish colour of the skin, almost stamp with characteristic distinction the oxalic-acid diathesis. Certain additional symptoms will aid the diagnosis. Feverish excitement, with dryness of the palms of the hands and soles of the feet, especially towards evening, may be notable in severe cases; while the tendency to boils is of very frequent occurrence. Irritability of the bladder is, perhaps, equally frequent in either case, but the condition of the urine will at once determine the difference.

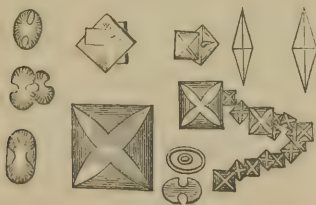
Physical Characters of Urine.—Clouded with much epithelium, and of a bright amber colour, somewhat

resembling the bright golden sherry colour of lithic-acid urine, but contrasting with the pale, whey-like urine of earthy phosphates, and the turbid orange-brown of ammoniacal urine, which, moreover, presents an iridescent pellicle on its surface, and is ropy and fetid. The specific gravity varies extremely, from 1·015, or less, to 1·025, or more. Quantity of urine not much increased. Reaction decidedly acid. No deposit of oxalate, unless present in some quantity, and after some hours or days, then appearing as minute, colourless, transparent, hemp-seed concretions, mingled with mucus as a cloudy deposit.

On being heated, the urine may become gelatinous, yet retain its transparency.

Microscopical Characters.—Crystals in three forms :

FIG. 5.



octohedra, the most common, or as dumb-bell shaped crystals; occasionally in the shape of small, red blood-globules, probably the earliest stage of dumb-bell oxalate. All these are here represented (Fig. 5).

Chemical Tests.—To determine the whole quantity

of oxalic acid—free, or in combination with alkalies and soluble, or with lime, a portion of which oxalate may be precipitated—the urine of twenty-four hours must be collected. This should be evaporated to about one-fourth its bulk, neutralized with ammonia, be strongly acidulated with acetic acid to keep the phosphates dissolved, and then a solution of chloride of calcium added. The oxalate of lime thus formed is to be separated by filtration, dried, converted into either the carbonate or the sulphate in the usual manner, weighed, and the oxalic acid calculated from the resulting carbonate or sulphate. If there be any reason to suppose that the oxalate is mixed with uric acid, then dissolve in hydrochloric acid, filter, neutralize with ammonia, and again acidulate with acetic acid (Hassall).

Should any oxalate of lime have become deposited before examination, this may be either separated or re-dissolved.

To estimate the *diagnostic* importance of oxalate of lime in the urine, it should be remembered that this state is of very frequent occurrence, and its presence cannot be regarded as signifying a morbid blood-condition, excepting in respect of the *quantity* secreted. A few minute crystals are quite compatible with health; but large crystals in large quantity, and *persisting* for a considerable period, indicate such morbid condition.

The following observations by Golding Bird, respecting the composition of oxalic-acid urine, relate to the circumstances under which it occurs.

In rather more than one-third of the cases examined, uric acid or urates existed in large excess, forming the greater bulk of the existing deposit. In all there existed a greater proportion of urea than in healthy urine of the same density; and in nearly 30 per cent. of the cases, so large a quantity of urea was present, that the fluid crystallized into a solid mass by adding nitric acid. The urate of ammonia found in the deposits of oxalic acid urine is occasionally tinted with a pink hue. An excess of phosphate frequently accompanies the oxalate. The presence of sugar in the specimens examined was exceptional.

Prout regarded the oxalic-acid diathesis as a substitute for that of lithic acid, the former being preceded and followed by the latter. Liebig demonstrated the intimate relation of lithic acid to urea and oxalate of lime; the two latter having been formed artificially from the former; and this conversion of lithic acid was shown by Wöhler's experiments to take place in the bodies of animals.

Oxalic-acid urine—properly so called from the quantity of this acid excreted—is therefore an expression of *many* morbid conditions. Taking patients indiscriminately in a hospital, Bence Jones concludes that oxalate of lime is notably present in the urine in

nearly one out of three. Diseases of many kinds, and of opposite characters, are apparently conducive to this result: indigestion, especially if attended with flatulence, and in cases also where no indigestion was ever experienced; skin diseases, and in cases where the skin was never affected; in acute rheumatism, acute gout, fever, and in diseases of women and children.

Sulphuric Acid (HO,SO_3) in Urine.

Diseases associated:—

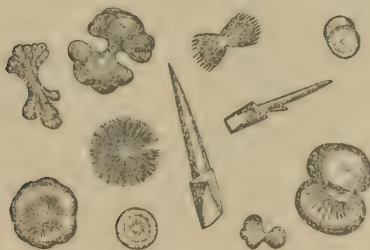
Increased with	Diminished with
Fever, simple.	Bright's disease, acute.
Rheumatic fever.	„ „ chronic.
Acute pneumonia.	Chronic diseases generally.
Pyæmia after confluent small-pox.	Jaundice, without fever.
Delirium tremens.	Cholera.
Acute capillary bronchitis.	Anæmia and chlorosis.
Acute phthisis.	
Typhoid fever.	
Small-pox.	
Milk fever.	
Acute pleurisy.	
Chorea.	
Diabetes mellitus.	
Cholera.	
Anæmia and chlorosis.	

Physical Characters of Urine are not, apparently, peculiar, and therefore not distinctive. They would appear to resemble generally those of febrile urine. No deposit of sulphates ever occurs, they being soluble in urine—acid or alkaline—including ammoniacal urine.

Microscopical Characters.—Crystals of sulphates may be readily procured by evaporating a small quantity of urine on a slip of glass. The sulphate of *potash* then appears in the shape of short six-sided prisms, terminated by six-sided pyramids; but frequently the body of the crystal is wanting, thus presenting a triangular-faced dodecahedron. Also in the shape of rosettes and dumb-bells (Fig. 6.) Sulphate of *soda* appears as decahedral crystals.

Chemical Tests.—By adding a soluble salt of baryta,

FIG. 6.



e.g., chloride of barium, the sulphate of baryta formed is insoluble and conspicuous, thus representing the

sulphuric acid present: but not discovered by merely inspecting the urine, in which the sulphates of potash and soda are absolutely soluble, whether the urine be itself acid or alkaline. The readiness with which the insoluble baryta sulphate appears will show the excess of sulphuric acid.

The *whole* quantity of sulphuric acid present may be determined as proposed by Dr. Bence Jones: about 500 grains of urine are weighed, and chloride of barium is then added in excess, a few drops of hydrochloric or nitric acid being used to ensure the solution of the phosphate of baryta. Heat is applied, and the liquid boiled for a few minutes briskly. The sulphate of baryta is filtered and washed until the clear liquid is perfectly free from chloride of barium. The filter is burnt, and the residue weighed. The amount of sulphate of baryta in a known quantity of urine is thus determined, and the whole amount in twenty-four hours can be calculated.

Diagnostic Value.—The interpretation of sulphuric acid in the urine is somewhat parallel to that of phosphoric acid. The quantity of either acid present absolutely and relatively to the other urinary constituents, is the question with reference to the blood-condition. Unlike phosphoric acid, *no part* of the sulphuric acid is ever deposited in combination, *i.e.*, as sulphates of potash and soda; they being the only sulphates (excepting, perhaps, a little lime-

sulphate), completely soluble in any urine, even alkaline urine. But the greater part—about three-fourths of the whole of the phosphoric acid—is in combination with these alkaline bases, and these phosphates are also completely soluble in any urine, and never deposited. While, therefore, mere inspection of the urine overlooks the greater portion of the phosphoric acid present, it discovers none of the sulphuric acid. On the other hand, the remaining small portion of phosphoric acid in combination with the earthy bases, lime and magnesia, being insoluble only in alkaline urine, their precipitation indicates and measures only the alkalescence of the urine,—by fixed alkali potash or soda, or the volatile alkali ammonia. Not even this chemical condition of the urine is discoverable through the sulphates, which never appear.

Chemical examination of the urine—as already described—by the formation of the sulphate of baryta, which is insoluble, and deposited accordingly, will discover the presence of sulphuric acid, and its whole amount.

Hippuric Acid ($\text{HO}, \text{C}_{18}\text{HNO}_5$) *in Urine.*

Diseases associated :—

Increased with	Diminished with
Liver disease, <i>e.g.</i> , cirrhosis.	Jaundice, absent.
Dyspepsia, atonic.	Typhus fever.

Increased with	Diminished with
Cholera.	Pneumonia?
Chorea.	
Diabetes mellitus.	
„ insipidus.	

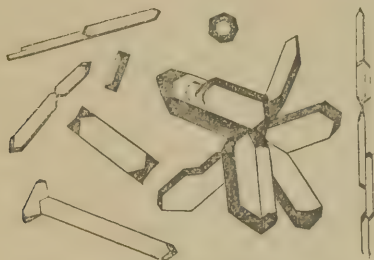
The General Symptoms are those of muscular weakness and nervous exhaustion, consequent, it would seem, on the deprivation of nitrogenous food and an excess of carbonaceous matter in the system. The accompanying condition of urine will, however, as usual, determine the diagnosis between this and other diseases, *e.g.*, excess of urea, phosphates, or oxalates, which present similar general symptoms.

Physical Characters of Urine.—The colour varies—pale, or, it may be, resembles that of febrile urine; the odour is generally like that of whey; specific gravity below rather than above the healthy average—1·020, and in one case (by Bouchardat) it varied from 1·006 to 1·008. Quantity copious. Reaction, generally, very faintly acid, neutral, or alkaline. A deposit of triple phosphate of magnesia not unfrequently occurs.

Microscopical Characters.—Crystals of the oblique rhomboidal prism, and its modifications, are obtained by evaporating two or three drops of fresh urine, to which a little hydrochloric acid has been added, on a slip of glass (Fig. 7). In stale urine, the hippuric

will be found converted into benzoic acid; but its crystals, obtained in like manner, are characteristically different—thin glistening scales.

FIG. 7.



Chemical Tests.—Neutralize the acid with lime, concentrate by evaporation, add hydrochloric acid, in a flask, to decompose the hippurate of lime; introduce ether in large quantity, and cork the flask, agitate from time to time, pour off the ethereal solution which floats on the surface, wash it with water to remove traces of hydrochloric acid, and then evaporate to obtain the free hippuric acid.

If the ether should not separate readily from the mixture, add a very small quantity of alcohol; the water added removes the latter, and any urea in solution, as well as the hydrochloric acid.

Lactic Acid ($\text{HO},\text{C}_6\text{H}_5\text{O}_5$) *in Urine.*

Diseases associated :—

Increased with

Febrile diseases.

Recurrent catarrh.

Osteomalacia.

Pyæmia.

Diseases associated :—

	Increased with	
Oxalate of lime and uric acid.		Leucæmia.
Diabetes mellitus.		Puerperal fever.
Rachitis.		Rheumatism ?

Physical Characters of Urine.—Not distinctive.

Microscopical Characters.—Crystals of the lactates of zinc, lime, and copper, may be obtained, which are characteristic ; the former especially, being thick rhombic tablets in clusters, and those of lime having the appearance of double brushes.

Chemical Tests.—Evaporate fresh urine to the thickness of syrup, by means of a low temperature with the water-bath, treat the residue with alcohol holding oxalic acid in solution, treat the alcoholic extract with an excess of hydrated oxide of lead, filter the solution, remove the excess of lead by sulphuretted hydrogen, boil the filtrate with oxide of zinc, filter again and evaporate to concentration, and lactate of zinc will appear with its characteristic crystals.

Lactate of lime may be formed by first procuring a solution of lactate of baryta, and then decomposing with sulphate of lime.

Or, the lactate of copper, from that of lime, by adding sulphate of copper.

Chlorides in Urine.

Chloride of sodium (NaCl).

Chloride of potassium (KCl).

Chloride of ammonium (NH₄Cl).

Diseases associated :—

Increased with	Diminished with
Diabetes mellitus.	Acute pneumonia.
Ague—cold and hot stages.	Acute pulmonary phthisis.
Chronic phthisis.	Acute capillary bronchitis.
Hot stage, and beginning of sweating.	Pleurisy.
	Acute rheumatism.
	Typhus fever.
	Typhoid fever.
	Scarlet fever.
	Erysipelas.
	Puerperal fever.
	Milk fever.
	Chronic febrile diseases.
	Cholera.
	Dropsy—cardiac, hepatic.
	Bright's disease—acute and chronic.

Physical Characters of Urine.—Not distinctive.

Microscopical Characters.—The chlorine is, for the most part, in combination with sodium, and the chloride of sodium readily crystallizes. By evaporating a drop or two of urine on a slip of glass, crystals are obtained in the octohedral form, distinguished from those of oxalate of lime by their principal axis being longer, and by not polarizing light. Half-octohedra, which are occasionally striated, is another form. Dodeca-

hedra, or twelve-sided crystals, are the rarest form. By evaporation also, or from a solution of the ash of urine, the salt often crystallizes in the form of crosslets and daggers. (Fig. 8.)

FIG. 8.



Chemical Tests.—Nitrate of silver, in solution, is a handy test for the presence, or qualitative determination, of chloride of sodium, in urine. One caution only is required: to strongly acidulate the urine with nitric acid, in order to prevent the precipitation of phosphate of silver; or the nitric acid may be added after the nitrate of silver, when any phosphate of silver will be immediately dissolved. (Thudichum.)

The quantity may be determined, either by weighing the white precipitate — chloride of silver; or volumetrically, by noting the quantity of a solution of nitrate of silver, of known and appropriate strength, required to separate the whole of the chlorine.

*Sugar (C₁₂H₁₂O₁₂) in Urine.**Diseases associated :—*

Diabetes mellitus.	Hysteria ?
Dyspepsia.	Epilepsy ?
Gout.	Asthma ?
Injuries of head.	Emphysema, pulmonary ?
Cholera.	Phthisis ?
Hypochondriasis.	Acute pneumonia—sputa ?
Urine of old persons.	Hooping-cough—after ?
After chloroform of 24 hours' administration.	
Pregnancy and lactation.	
Lactation with suppression.	

General Symptoms of Diabetes Mellitus—Mellituria—Glucosuria.—Approaching insidiously, the quantity of urine becomes notably increased, owing to the diuretic action of sugar: micturition, also, more frequent and urgent, from the presence of sugar in the urine secreted, and irritability of the bladder is established. This constant drain of water through the kidneys is necessarily attended with a diminished discharge through other channels; hence dryness and roughness of the skin, the cuticle powdering off, constipation, a pasty tongue, not unfrequently red, unquenchable thirst, craving hunger, with progressive emaciation, partly due to

actual wasting, partly to the drying up of the body consequent on the incessant renal discharge of water from the system. Debility progressively accompanies this wasting and mummification, yet the mind remains unclouded to the last.

Diabetes mellitus is the expression sometimes used for that disease whereof sugar in the urine is the sign; and this attributive title seems necessary to distinguish ordinary diabetes from a variety contra-designated *Diabetes insipidus*. In the former, farinaceous matters are probably converted into dextrin, and thence at once into grape-sugar; but there is some reason to believe that this succession of metamorphoses may be interrupted, and that an *insipid* sugar is then formed intermediately between dextrin and sugar of milk (Bence Jones). This tasteless sugar resembles sugar of milk, differing from it in not giving rise to mucic acid and in undergoing fermentation. It can be converted into grape-sugar by the action of acids.

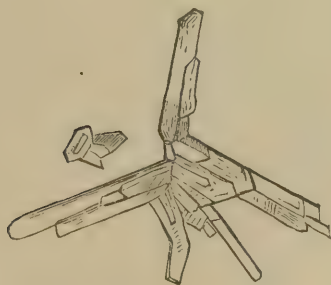
Diabetes insipidus has received other names—*Polydipsia* (Becquerel), *Diuresis* and *Hydruria* (Willis). The secretion thus signified, of a large quantity of *watery* urine, is probably a distinct disease. Aqueous diabetes commonly occurs in connection with hysteria; and the term *hydruria* distinguishes it from *azoturia*, of which disease an excessive excretion of *urea* is the prevailing characteristic. The absolute amount of *urea* excreted in the twenty-four hours may be in-

creased in hydruria; no sample, however, of such urine contains its normal proportion to the water secreted.

Physical Characters of Urine.—Clear, pale-straw, or greenish tint, sweet smell and taste, specific gravity high, averaging 1·040, and the quantity much increased, to 100 ounces, or even 400 ounces, in twenty-four hours. A crystalline deposit of sugar readily forms as an efflorescence on any clothing or other surface where the urine may happen to dry. The reaction is acid, but neutral or slightly alkaline if the quantity of sugar be small and the urine fresh.

Microscopical Characters.—Crystals in the shape of rhombic plates, six-sided, aggregated into roundish granules, or as single plates. (Fig. 9.)

FIG. 9.



Chemical Tests.—The composition of diabetic urine is peculiar in containing a *foreign* ingredient—glucose,

or sugar of the grape, and excreted, possibly, in quantity varying from 1 lb. to 2 lbs. or more, in twenty-four hours; whereby a patient may pass more than his own weight of sugar in the course of a few months. The urine contains, also, usually rather more than less of its ordinary constituents.

Diagnostic Value.—Saccharine matter is occasionally present, and as a mere trace, in healthy urine; but any more obvious quantity, and *persisting*, is abnormal.

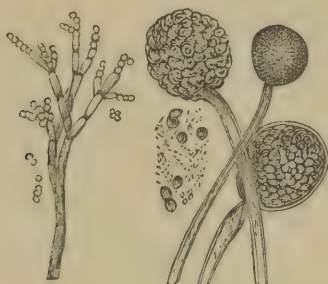
To estimate the pathological significance of diabetic urine, therefore, the constant presence of sugar in any notable quantity, rather than its absolute amount, is the diagnostic sign of consequence.

To detect this morbid condition in its infancy—indicating a corresponding blood-condition—certain tests, more delicate even than the production of the rhombic crystals, can be applied with signal success.

Yeast or Fermentation test:—This is easily applied. Add a small quantity of yeast to some of the suspected urine in a saucer; invert a test-tube filled with this mixture, and stand it in the saucer; then place the whole in a warm room. If sugar be present, fermentation soon begins, and bubbles of carbonic acid rising in the tube accumulate and depress the fluid. Minute fungoid growths also are developed, which can be seen with the aid of the microscope. Another fungus—*penicilium glaucum*—(Fig. 10, to left) the mildew that over-spreads decaying vegetable or animal matter, and which

may appear in *non-saccharine* urine, is apt to be mistaken for this “yeast-plant”—*torula cerevisiæ*. (Fig. 10,

FIG. 10.



to right.) Their distinctive microscopic characters were pointed out by Dr. Hassall.*

Certain *chemical* tests are more conclusive. They all depend on the facility with which the composition of diabetic sugar is changed; and this can be readily effected by salts of copper, and by alkalies.† Full directions for the successful application of these tests are given in Golding Bird's work;‡ the following particulars, however, are essential to our purpose—the early and exact detection and discrimination of diabetic urine:—

Copper, or Trommer's test:—Add to the suspected urine in a large test-tube just enough of a solution of

* “The Urine in Health and Disease,” 1863, pp. 149—151.

† See “Med.-Chir. Review,” January, 1853. Lionel Beale,

‡ “Urinary Deposits.” Edit. by Dr. Birkett.

sulphate of copper to communicate a faint blue tint. A slight deposit of phosphate of copper generally falls. Liquor potassæ must then be added in great excess; a precipitate of hydrated oxide of copper first falls, which redissolves in the excess of alkali, if sugar be present, forming a blue solution like ammoniuret of copper. On gently heating the mixture to ebullition, a deposit of red suboxide of copper falls, if sugar be present.

Cappezzuoli's test:—Add a few grains of blue hydrated oxide of copper to urine in a conical glass vessel, and render the whole alkaline by adding liquor potassæ. If sugar be present, the fluid assumes a reddish colour, and in a few hours the edge of the oxide deposit acquires a yellow colour, which gradually extends through the mass, owing to the reduction of the oxide to a metallic state (suboxide?).

Potash or Moore's test:—Place in a test-tube about two drachms of the suspected urine, and add nearly half its bulk of liquor potassæ. Heat the whole over a spirit-lamp, and allow active ebullition to continue for a minute or two; the previously pale urine will become of an orange-brown or even bistre tint, according to the proportion of sugar present. The subsequent addition of an acid generally causes the evolution of an odour of boiling molasses. Should the liquor potassæ contain lead, a dark colour is produced by the sulphur in the urinary excretion acting on it,

which might lead one to suspect the presence of sugar when none exists—a source of error first pointed out by Owen Rees. Hence it is important to preserve the test-solution in bottles of green glass free from lead.

For Traces only of Sugar.—Certain tests are appropriate for the detection of sugar, when present in otherwise unappreciable small quantity—as a mere trace. The application of such tests implies the previous separation of some of the other constituents, which would interfere with their action.

(a) *Brücke's test.*—Add to the suspected urine, neutral acetate of lead, and afterwards basic acetate of lead. Separate the precipitate by filtration, and add ammonia to the solution. The precipitate, by ammonia, is decomposed by oxalic acid, or suspended in water, and sulphuretted hydrogen passed through it. The filtered solution contains the sugar, which can then be detected by any of the tests already described.

This process will detect the seventh of a grain of sugar, diluted with more than six ounces of water; and two-thirds of the whole quantity of sugar present in a solution can be separated.

(b) *Maumene's test.*—Soak strips of woollen rag in a solution of perchloride of tin—one part of perchloride to two parts of water—for four or five minutes. Dry the slips over a water-bath. Let fall a drop of the suspected urine on one of these prepared strips, dry it,

and expose to the dull red heat of a spirit-lamp. If only a trace of sugar be present, a black spot appears.

(c) *Chromate of Potash test*.—Mix equal parts of neutral chromate of potash and solution of potash with the suspected urine, and boil; if sugar be present, a green colour,—by the formation of oxide of chromium, is produced. (Horsley.) A modification of this test may be made:—A solution of bichromate of potash is decomposed by excess of sulphuric acid; mix this with the urine, and boil; a beautiful green colour appears. This reaction is not affected by urea, the urates, or albumen. (Luton.)

To Estimate the Quantity of Sugar.—By the *Fermentation Test*, the quantity of sugar present in diabetic urine, may be estimated according to either of two of the results of this process:—

(a) *By measuring the volume of Carbonic Acid produced*.—The mixture of yeast and urine is placed in a graduated tube, inverted over mercury. When the fermentation is finished, in from six to twelve hours, at a temperature of 100° Fah.; the volume of gas formed is thus indicated, and subject to correction for temperature and pressure, the amount of sugar can be calculated. One cubic inch of carbonic acid represents nearly one grain of sugar.

(b) *By the diminution in specific gravity or weight of the urine, after destruction of the sugar by complete fermentation; as compared with the weight before this*

process—Dr. W. Roberts' method. The difference of specific gravity here indicates the quantity of sugar. Two portions of urine, of four ounces each, are placed in separate bottles of about twelve ounces capacity. In one is placed a piece of German yeast, the other is tightly corked. Both are placed in a warm place for twenty-two hours, until fermentation is complete. The bottles are removed to a cooler locality, and after two hours the density of the fluid in each bottle is tested by the urinometer. Every degree of density lost, by the fermented sample, indicates one grain of sugar in each fluid ounce of urine.

Albumen in Urine—Albuminuria.

Diseases associated :—

Bright's disease, acute	Rheumatism, acute.
and chronic.	„ subacute.
Scarlatina.	Pregnancy.
Disease of heart.	Intermittent fever.
Cholera.	Measles.
Diarrhœa.	Small-pox.
Puerperal convulsions.	Peritonitis.
„ fever.	Pleurisy.
Typhoid fever.	Erysipelas.
Typhus fever.	Paralysis.
Pneumonia.	Purpura.
Bronchitis.	Diseases with blood in
Phthisis.	urine.

General Symptoms of Bright's disease of the kidneys.—Certain structural changes in the kidney are the immediate causes of the symptoms. These changes are : congestion,—the kidneys being enlarged by engorgement of blood, and having a deep purple colour, followed by interstitial effusion, affecting chiefly the cortical or secreting portion of the gland, with enlargement, pale colour, and moderately firm consistence : degeneration,—fatty or waxy (amyloid) degeneration of the effused matter, with some physical alterations of colour and consistence : or, lastly, partial absorption and contraction,—producing a small, firm, remnant kidney, having an irregular puckered surface, and granular aspect when the adherent capsule is withdrawn—granular degeneration.

The first of these conditions has been named by Dr. G. Johnson acute desquamative nephritis,—fibrinous casts of the uriniferous tubules, with epithelial cells, coming away in the urine ; the second, chronic non-desquamative nephritis ; while the third condition might be termed the atrophied or remnant kidney.

Whether we regard these structural changes as a consequential series, or as so many independent forms of renal disease, they are one and all included under the title—Bright's disease,—for with each, albuminous urine is invariably connected.

The symptoms incident to each of these alterations

of structure necessarily vary, yet they are substantially the same.

Congestion of the kidneys, beginning with pain or weight in the loins, sickness, and general febrile disturbance, is accompanied with albuminous urine, and the retention of urea and water in the blood, with its effusion into the cellular texture generally: thus constituting "febrile dropsy." The blood and urine have, in respect to each of their prominent constituents, albumen and urea, changed places. While, therefore, the nutrition of the body is undermined by the constant abstraction of the one, the system, through the blood, is poisoned by the retention of the other. Hence the symptoms of uræmia, which are of a typhoid character, and prominently those of "febrile oppression" — the functions of the nervous system being overwhelmed, as by intoxication, and stupor or coma induced. Urea in the circulation may affect various organs, inducing particular symptoms. Meningitis with its symptoms, or those of cerebral irritation only — as headache, convulsions; pleurisy, pericarditis, or peritonitis; or irritation of the bronchial, or of the gastro-intestinal mucous membranes. Add to which degeneration of other organs, especially the heart, liver, and vessels of the brain, is not unfrequently a co-existing or consequential condition, thus giving rise to *their* additional symptoms. Dropsy, owing to the

concomitant retention of water, may be called an accidental symptom.

The other, or the essential symptoms of Bright's disease of the kidneys, are connected also with the alterations of *structure* which occur in consequence, or perhaps independently, of congestion; but the albumen returns to the blood, and the water, about proportionately, to the urine, the urea and other solid urinary constituents being still retained in progressively greater proportion in the blood; thus reducing the urine to a mere discharge of water, and often in great quantity. The scanty secretion of urine with congestion, contrasts with this diuresis-anazoturia. Micturition is more frequent, and perhaps urgent, in the one case, and more abundant in the other. In both, irritability of the bladder is excited by the unaccustomed urine.

Physical Characters of Urine, in Bright's disease.—Colour, smoky-brown; easily froths, owing to the presence of albumen; specific gravity low—averaging 1·014—by abstraction of urea. Quantity of urine much diminished, owing to the reduced proportion of water. Subsequently, the urine becomes pale and opalescent, and is less apt to froth, there being much less albumen; the specific gravity declines yet lower, down perhaps to 1·004, while the quantity of urine is increased, approaching even to diuresis. The reaction is, generally, much less acid than in health.

The specific gravity of the serum of the blood is

reduced to 1·018 or even to 1·015, as compared with that in health, which ranges between 1·029 and 1·031.

Microscopical Characters.—Casts of the uriniferous tubules, blood, and perhaps pus, may pass in the urine, which presents accordingly characteristic appearances under the microscope; but their description scarcely relates to the composition of the urine secreted.

Chemical Tests.—The solid constituents of the urine, amounting in health to about 68 in 1000 of urine, in Bright's disease declines to 14, 12, or even 6 parts only in 1000. This is chiefly due to the abstraction of urea, alluded to in connexion with the altered physical characters of the urine. The quantity of albumen contained in the urine varies exceedingly—from a mere trace, to possibly 545 grs. in the twenty-four hours. (Parkes.)

The presence, or, as in the early stage it might be termed, the substitution of albumen for urea, is easily discovered and readily distinguished, provided only certain precautions be observed in making the examination.

They relate either to the chemical composition of the urine submitted to examination, or to the tests employed; chiefly, these precautions have reference to the urine itself.

Albuminous urine is not merely a solution of albumen. So far as it *alone* is concerned, by applying

heat to such urine, the albuminous portion—white of egg—begins to coagulate at 160° Fahr., and gradually solidifies as the temperature rises to 212° . But this urine contains other ingredients, and their variations in quantity interfere with the coagulation of the albumen.

Thus, if the urine be alkaline, or even neutral—whether from the presence of volatile alkali, carbonate of ammonia, or from fixed alkali, as soda—either alkali will combine with albumen, and neither of the resulting compounds being coagulable by heat, the urine remains clear when heat is applied. The albumen is not discovered, although perhaps abundant. Or again, if an opposite condition exists—should the urine be over acid, from the presence of a free acid, as the acetic or hydrochloric, it will combine with albumen, and the acetate and hydrochlorate of albumen being uncoagulable by heat, the urine remains clear when heated. The albumen is concealed.

Supposing, however, that, on the application of heat, a white flaky precipitate does fall, resembling albumen, it may not be albumen. Earthy phosphates are likewise precipitated by heat. To distinguish between these two deposits—phosphates and coagulated albumen, as well as to evolve albumen concealed by an alkaline or over-acid state of the urine—heat having been applied, nitric acid (strong) should then be dropped into the test-tube, containing supposed albu-

minous urine. If the deposit be phosphates, they are re-dissolved; if albumen, it is more firmly coagulated.

Nitric acid *unaided* will precipitate albumen, but it also liberates lithic acid from the lithates, and combines with urea; when, therefore, either of these constituents is present in excess, a brown deposit of lithic acid or nitrate of urea forms and disguises the albumen. Both precipitates, however, together with the lithates, are re-dissolved by heat, which, on the contrary, discloses albumen.

In short, *heat* clears off any difficulty arising from lithic acid, the lithates, and urea; *nitric acid* clears off any difficulty arising from the (earthy) phosphates, at the same time liberating and evolving albumen from any prevailing alkaline or mineral acid condition.

Nitric acid, in respect of its behaviour to albumen, disputes with heat the privilege of disclosing the presence of this abnormal constituent of urine. Nitric acid unites with albumen, forming what may be called nitrate of albumen, which is not coagulable by heat. Consequently, if only just so much acid be added to albuminous urine as shall combine with all the albumen present, and form this nitrate, none of the albumen will appear when heated. Nitrate of albumen being *insoluble* in nitric acid, appears when *more* acid is added; but is again re-dissolved on the addition of an *excess* of acid. The happy *medium*

quantity of acid is necessary to exhibit albumen,—not just an equivalent, which combining with the whole amount present, renders it insoluble, although heated; this would be too small a proportion of acid; while an excess—above that proportion in which the nitrate of albumen is insoluble—redissolves it.

To strike the balance, and moreover obviate all other possible difficulties to which I have referred, the right method of examining supposed albuminous urine is simply this:—Pour a *small* quantity—say a fluid drachm—of the urine into a test-tube; heat it to the boiling point, and then drop in *two* or three drops only of strong nitric acid. If phosphates have been precipitated by the heat applied, they will be redissolved, and the white flakes of coagulated albumen appear more clearly. On being allowed to stand, it will subside in the tube, leaving the urine above clear; thus defining the quantity of albumen present in any given quantity of urine examined. This will be found, as already said, to vary between two extremes; a slight white cloudiness subsiding as a little flaky deposit, or part or the whole sample becoming solid and white, like coagulated albumen of an egg, in the tube.

To exactly estimate the quantity of albumen.—Either of the two following processes may be resorted to:—

Take 500 grs. of the urine of twenty-four hours, and boil it in a flask, nitric acid being added subse-

quently, to secure coagulation of the albumen, and to dissolve any of the phosphates deposited by boiling. Then let the coagulated albumen subside by standing the flask, decant off the clear fluid, and throw the residue upon a weighed filter. Wash the collected albumen on the filter, with hot distilled water, to bring away saline matter; dry on the water-bath, and weigh.

Or, acetic acid may be added, in just sufficient quantity, and the urine boiled, thus to effect coagulation. The process is then concluded in like manner.

Diagnostic Value.—The significance of albuminous urine is its *persistence*, which is pathognomonic of Bright's disease of the kidney. With rare exceptions, this disease is invariably accompanied with albuminous urine, and this condition of urine persisting is a sure sign of that disease, and of no other.

Temporarily, albuminous urine is associated with many other diseases, most of which are specified in the table.

Bile in Urine.

Diseases associated :—

Jaundice from obstruction.	Small-pox.
Acute Hepatitis.	Scarlet fever.
Cirrhosis of liver.	Puerperal fever.
Acute yellow Atrophy.	Pyæmia.

Pneumonia.

Urine in hot weather.

Urine of Pregnancy.

General Symptoms of Jaundice.—Certain structural changes in the liver are the immediate causes of the symptoms. These changes are : — some *mechanical* impediment, which, precluding a free flow of bile into the duodenum, permits absorption of the bile imprisoned. The obstacle in question may be constriction, or closure of—as by a gall-stone impacted in—the common bile-duct, the hepatic duct, the cystic duct, or of the bile-ducts within the liver;* or the impediment may be due to some external cause of pressure on either of the ducts, as by thickening of the pylorus, duodenum, or head of the pancreas; or a tumour within the liver itself, overlaying the ducts. Without any obvious mechanical impediment to the free escape of bile, *suppression of its secretion* is more frequently the occasion of deficient elimination of bile. Structural disease of the liver, *e.g.*, inflammation, acute and chronic, cirrhosis, fatty degeneration, operates in this way. So, also, various blood-poisons, *e.g.*, through snake-bites, pyæmic infection of the blood, typhus, and malaria, intermittent, remittent, and yellow fever, severally give rise to jaundice. Ether and chloroform, likewise, are said to occa-

* “Diseases of the Liver,” Frerichs. Translated by C. Murchison, M.D. 1860. Vol. I.

sionally have this effect. In all these cases the liver itself may be structurally healthy; the blood-poison alone is the cause of a suppressed secretion of bile, which, in turn, reacting upon the blood, induces jaundice. Similarly, through the nervous system, mental emotions have, in some cases, paralysed the liver, and produced this disease.

The symptoms of each of these causative conditions are those of jaundice—yellow or yellowish-green discolouration of the skin and conjunctivæ, of the urine, and light drab-coloured fæces. These appearances are due to the presence or absence of biliary colouring matters. The retention of bile in the blood circulating is, like urea, sedative to the vital powers of the nervous and muscular systems, irritative in its operation on certain parts, locally. Hypochondriacal depression, weariness, and great weakness, are not unfrequently accompanied with an intolerable itching of the skin, and irritability of the urinary bladder, as biliary colouring-matter escapes by the urine. The want of bile in the small intestine renders the process of digestion incomplete; and the inappetency or even loathing of food occasioned by the bile retained in the system, is accompanied with imperfect chyfication of the scanty ingesta, and the separation of pale yellow faecal matter; while habitual constipation is relieved by occasional colicky diarrhœa. Progressive emaciation necessarily follows this constant

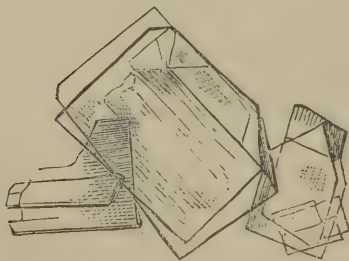
starvation ; and the withered, discoloured appearance of the individual—melancholy, exhausted, and dyspeptic—cannot fail to convey the impression of jaundice. Examination of the urine will at once settle the question.

The passage of a gall-stone is attended with paroxysmal pain in the epigastrium, always severe, sometimes excruciating, according to the size of the stone *in transitu*, hiccup, vomiting, and constitutional disturbance ; but, in general, inflammation and its symptomatic fever do not supervene.

Physical Characters of Urine.—Colour, dark saffron, green or black ; leaving a bright yellow, or other stain, on white linen. Other characters are not peculiar.

Microscopical Characters.—Certain constituents of the bile, when present in urine, may be obtained in

FIG. 11.



crystalline forms. Taurine, as regular hexagonal prisms, with four or six-sided sharp extremities, the

elementary form being a right rhombic prism. Crystals of cholesterine may also be found. (Fig. 11.)

Chemical Tests—are the most delicate means of detecting the presence of biliary colouring matters, when escaping by the urine in quantity too minute to be visible, or made visible by staining linen.

Nitric Acid.—Pour on a white plate, or sheet of writing-paper, a small quantity of the suspected urine, so as to form an exceedingly thin layer, and carefully allow a drop or two of nitric acid to fall upon it. An immediate play of colours, green and pink predominating, will, if the colouring matter of bile be present, appear around the spot where the acid falls.

Heller's test:—Add to the urine any albuminous fluid—serum of blood or white of egg; then pour in sufficient nitric acid to produce a considerable albuminous coagulum. Examined after a short repose, it will present a bluish or green colour if bile pigment existed in the urine; whilst, if none were present, the deposited mass will be white or merely slightly yellow.

But albumen precipitated by nitric acid in urine, destitute of bile, is more or less coloured, bluish or reddish; this appearance, then, arising from the action of nitric acid on the colouring matter of the urine—uroxanthine. Dr. Basham has observed this urinary coloured albumen most frequently in acute renal dropsy, and it is a very unfavourable sign.

Acetate of lead precipitates albumen, if present, in bilious urine, of a yellowish colour.

Colour of Phosphates.—After exposure of urine for a day or two, crystals of triple phosphate are deposited, having a yellow tinge. A very delicate and pretty test of bile colouring matter. (Hassall.)

For Bile Acids.—(a) *Pettenkofer's test*: To a small quantity of the suspected urine in a test-tube, two-thirds of its volume of sulphuric acid are to be carefully added, taking care that the mixture, which soon becomes hot, never exceeds a temperature of 144 degrees. Three or four drops of a solution of one part of sugar to four of water are then added, and the mixture shaken. A violet-red colour is developed if bile be present. This familiar test was not regarded favourably by Golding Bird. His experience led him to doubt its accuracy, and in applying it there are numerous sources of fallacy to be guarded against; chiefly, that the action of sulphuric acid on sugar develops a red colour in the absence of bile. A mixture of albumen or oil with sugar will, even in very minute quantities, under the action of sulphuric acid, produce a purple or scarlet colour, as Raspail long ago observed.

(b) *Hoppe's test*—for a trace of bile acid. Treat the suspected urine with excess of milk of lime, and boil for half an hour. Filter, and evaporate the clear fluid nearly to dryness, and then decompose with excess of strong hydrochloric acid. Boil the mixture for half an

hour, renewing the acid from time to time, so as to prevent the spurting which would occur from over-concentration. Let the mixture completely cool, and then dilute with from six to eight times its volume of water. Filter the turbid solution, and wash the resinous mass, until the water runs through quite colourless. Dissolve the residue in spirit, containing 90 per cent. of real alcohol, decolorise with animal charcoal, again filter, and evaporate to dryness over a water-bath. The yellowish resinous residue is pure *choloidic* acid. On warming it, a peculiar musk-like odour is emitted. Dissolve this resinous matter in a little caustic soda and warm water, add a little sugar, and let fall, slowly, three drops of concentrated sulphuric acid into the mixture. The resinous acid is, at first, precipitated; but afterwards, the flakes adhering to the glass are slowly dissolved by adding more sulphuric acid, and there appears an entirely clear fluid, of a beautiful *dark violet* colour (Virchow's Archiv, vol. xiii.; Archives of Med., vol. i.). This test results from an elaborate process, but it is a very delicate and infallible one.

The following useful tables are from Dr. Golding Bird's work;* they contain reference to some deposits not hitherto described in this work, but which are here incidentally introduced:—

* "Urinary Deposits," &c. Edited by Dr. Birkett. 1857.

(1) *Table for the Microscopical Examination of Urinary Deposits.*

Deposit	amorphous,	and disappears on the addition of	
		liquor potassæ	Urates.
„	„	and permanent on the addition of	
		liquor potassæ . .	Phosphate of lime.
„	visibly crystalline,	and the crystals octohedral*	
			Oxalate of lime.
„	„	and the crystals hexagonal tables	
		soluble in ammonia . .	Cystine.
„	„	and the crystals, prismatic or pen-	
		niform, not soluble in ammonia,	
		but in acetic acid	Neutral triple phosphate.
„	„	and the crystals radiated or folia-	
		ceous, not soluble in ammonia,	
		but in acetic acid, with efferves-	
		cence	Carbonate of lime.
„	„	and the crystals radiated or folia-	
		ceous, not soluble in ammonia,	
		but in acetic acid, without effer-	
		vescence	Bibasic triple phosphate.†

* Arsenious acid, chloride of sodium, and the protoxide of antimony, assume the octohedral form, but are rarely present.

† Is not yet proved to exist in urine. (Thudichum.)

Deposit visibly crystalline, and the crystals dumb-bells
not soluble in ammonia, but in
acetic acid, with effervescence.

Carbonate of lime.

- | | | |
|---|---|---|
| „ | „ | and the crystals dumb-bells; soluble by heat, but not in ammonia, nor acetic acid. Lithate of soda. |
| „ | „ | and the crystals dumb-bells; insoluble by heat, ammonia, and acetic acid. Oxalurate of lime.* |
| „ | „ | and the crystals dumb-bells, with fringed edges; insoluble in alcohol and acetic acid, but soluble in liquor potassæ . Lithic acid. |
| „ | „ | and the crystals lozenge-shaped or compound; insoluble in acetic acid and ammonia . Lithic acid. |
| „ | „ | and the crystals spherical, with or without spicules; soluble by heat Lithate of soda. |

* Is not yet proved to exist in urine. (Thudichum.)

The sediment may be *organized*; consisting of mucus, pus, epithelial cells from the genito-urinary passages, semen, blood, casts of uriniferous tubes, various other cells, and *débris* of tissue; or stringy, coagulable by acetic acid, and consisting of a tenacious matrix with cells, some small and round, others large and flat, with oval nuclei,—it is mucus; or consisting of spherical globules, not imbedded in a matrix, about $\frac{1}{1800}$ th of an inch in diameter, studded with molecules and granules, and containing a double or triple nucleus on the addition of acetic acid,—it is pus.

(2) *Table for Discovering the Nature of Urinary Deposits by Chemical Reagents.*

Deposit white, and soluble by heat . . .	Lithates.
„ „ and insoluble by heat, but soluble in ammonia	Cystine.
„ „ and insoluble by heat and ammonia, but soluble in acetic acid . .	Earthy phosphates.
„ „ and insoluble by heat, ammonia, and acetic acid . .	Oxalate or oxalurate of lime.
„ coloured, and visibly crystalline . .	Lithic acid.
„ „ and amorphous, but pale, and readily soluble by heat	Lithates.
„ „ deeply, amorphous, and slowly soluble by heat.	Lithates stained by purpurine.

GENERAL TREATMENT.

The rational remedial treatment of any morbid condition is, essentially, the removal of the cause or causes in operation: its preventive, their anticipation.

Having, therefore, made a running commentary on the removal of the local diseases which induce vesical irritability, it became necessary, in order to complete its curative treatment, to trace the *pathology* of the constitutional causes which generally are in operation,

with their accompanying morbid conditions of urine, as the immediate causes; describing the physical and microscopical characters, and the chemical tests, of these causative conditions, and estimating their diagnostic value as constitutional symptoms.

All this will lead to the removal of the causes referred to, and their remedial treatment will be further enlightened by remembering the social origin of constitutional causes—a primary aspect of etiology, which is, however, more especially suggestive with reference to preventive treatment.

Lithic Acid, and Lithates—Treatment. —The pathological origin of lithic acid in excess is mal-assimilation, primary or secondary; or it denotes an excess of animal food over and above the wants of the system, which is accordingly expelled *in limine* from the blood through the kidneys, without having contributed to the nourishment of the body. Hygienic measures, therefore, are primarily important. A reduced proportion of animal food is obviously the leading curative measure, and active exercise daily to increase the elimination of any excess is equally necessary.

No remedial measures are at present known for directly correcting mal-assimilation in respect to lithic acid or other products. The effect of increased bodily exercise may be to increase the destructive metamorphosis of the highly nitrogenous textures, *i.e.*, muscle, and thus directly increase the production of lithic acid:

but this may also react beneficially in subsequently correcting the mal-assimilation.

Lithic acid passing off in the urine as lithate of ammonia is liable to be decomposed by the action of any free acid present in the urine; and lithic acid itself being insoluble appears as a deposit of reddish-yellow sand, consisting of crystals, which may aggregate and form a calculus. Hence the administration of *alkalies* to *neutralize* the acidity of the urine is indicated, of which bicarbonate of potash is, perhaps, the best for oft-repeated use. Other alkalies employed for this purpose are the bicarbonate of soda (as "Vichy water") the acetates, tartrates, and citrates of soda and potash, phosphates of soda and ammonia, and borates of soda and potash. Conversely, the *removal* of any source of *acidity* is also indicated; but this refers again to hygienic considerations. With regard to food, the vegetable acids, or that which will form them, as sugar or starch in the food, should, in Dr. Bence Jones's opinion, be prohibited. On the other hand, free perspiration to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Warm clothing, warm bathing, friction with horsehair gloves and belt—an excellent skin stimulant—and diaphoretics, are most efficacious.

Lithate of ammonia being soluble in urine at the temperature of the body, its solution is thus secured,

provided only that fluid be not overcharged. Dilution of the urine will best prevent supersaturation and deposit. The free use of aqueous drinks or soda water, is calculated to fulfil this indication, and thus probably prevent the formation of a lithate of ammonia calculus. Diuretics, which increase the secretion, will also aid the dilution of urine, and, moreover, tend to eliminate lithic acid or lithates from the system. The wine of colchicum, in doses of ten minims and upwards three times a day, prescribed with the carbonate of potash to keep the lithic acid in combination, the resulting lithates themselves being further held in solution by the administration of diluents—will together carry off both, and soothe the irritability of the bladder which accompanies their discharge. Saline aperients seem to contribute to this desirable result. Any prolonged subjection to such a course of elimination, requires also the simultaneous action of small doses of blue pill, apparently to maintain the proportionate secretion of bile, which otherwise being virtually retained as compared with the secretion of urine, would disturb the balance of their constituents in the blood.

Preventive Treatment recognises the same rules with regard to food and exercise; alkalies occasionally to intercept the deposit of lithic acid; and dilution to secure the solution of lithates.

Urea, excess in Urine — Treatment.—It should be

remembered that urea—like uric acid, from which it may be derived—is produced, physiologically in the system, by the destructive metamorphosis of the highly nitrogenous textures, *i.e.*, muscle. Nitrogenous food is also, perhaps, a direct source of urea, and is assuredly followed by a rapid and very considerably increased production of this constituent of the urine. Its pathological origin is apparently similar; an excess being produced in connection with febrile conditions, and a deficiency in those of an opposite character. Consequently, the indications of curative treatment would appear to be: to lessen the daily toil and harass, which are well known to be associated with ureal diabetes, and, still guided by pathology, to reduce the supply of animal food. But this latter indication is not confirmed by experience. It is found necessary to repair the system by a generous diet, aided by tonics and alcoholic stimulants; the latter seeming to supply a material which readily oxidates, thus protecting the muscular tissue from premature decay, with that excessive production of urea which rapidly runs off through the kidneys and incessantly irritates the bladder. The quantity of urine, and thence the frequency and urgency of micturition, may be reduced by opium, which tends also to soothe the general nervous excitement that accompanies exhaustion of mind and body.

Preventive Treatment is necessarily guided by similar considerations, only with an anticipatory application.

Phosphoric acid, and Phosphates—Treatment.—Guided by its pathological origin, an excess of phosphoric acid, in combination with alkaline or earthy bases, suggests, primarily, the endeavour to arrest, if possible, that destructive metamorphosis of nervous tissue which generates phosphoric acid in abnormal quantity. Consequently, temporary freedom, at least from all anxiety and corroding care—in short, mental relaxation—is primarily imperative. But the phosphatic diathesis is encouraged by vegetable food. A more animal diet, therefore, with beer and wine, is scarcely less imperative.

Deposition of the Phosphates—phosphatic urine, implying, as it does, an alkaline state of this fluid, suggests the use of mineral acids. The nitric and nitro-muriatic acids diluted, are the most useful. They are generally combined with vegetable tonics, as cinchona, and with apparent advantage. Opium also will aid in restoring acidity to the urine, besides subduing nervous excitement. Benzoic acid has been highly recommended, it being converted into hippuric acid during its passage through the system. The earthy phosphates, *i.e.*, of lime and magnesia, are thus held in solution and become invisible; the alkaline phosphates, *i.e.*, of soda and potash, never appearing. But the deposition of the former is effected by an excess of *fixed* alkali, —soda or potash in the urine. Another occasion of phosphatic urine, is an inflammatory state of the

urinary mucous membrane, with the secretion of mucus, which acting apparently as a ferment, induces the decomposition of urea and liberation of carbonate of ammonia—a *volatile* alkali. The urine thus becoming alkaline, deposits the triple phosphate of ammonia and magnesia with phosphate of lime. As regards the mere deposition of these (earthy) phosphates, mineral acids will, in like manner, counteract this tendency. Alkalies, however, have been recommended by Dr. Owen Rees, with the view of reducing the acidity of the urine as secreted, thus preventing its irritating the mucous membrane of the bladder, less mucus is secreted, and the urine in the bladder actually becomes more acid. The further treatment of cystitis, acute and chronic, was considered at p. 80.

Preventive Treatment is determined by precisely the same considerations respecting the generation of phosphoric acid in excess, and thence the formation of phosphates in excess; and also respecting the deposition of (earthy) phosphates in the urine, whether by fixed or volatile alkali.

Oxalic acid, and Oxalates—Treatment.—Considering the certain pathological origin of oxalic acid, in excess,—by the primary mal-assimilation of sugar and sugar-forming food, such food is contra-indicated. Every species of vegetable food is questionable; and those which contain oxalic acid, *e.g.*, rhubarb, sorrel, onions, and tomato, or certain medicines, *e.g.*, alkaline salts

with a vegetable acid, are unquestionably forbidden. Considering also the probable production of this acid, in excess, by the destructive metamorphoses of the nitrogenous tissues in secondary mal-assimilation, and its association with, or derivation from, lithic acid, a nitrogenous diet would seem to be contra-indicated. Nevertheless, experience shows that animal food, with brandy-and-water instead of beer or wine, form a suitable diet; but the water should be distilled, to deprive it of lime, with which the oxalic acid otherwise combining would lead to the formation of a urinary calculus.

Appropriate medicinal treatment will aid regimen. The mineral acids are efficacious, particularly hydrochloric and nitro-muriatic acids, in conjunction with bitters. They were recommended by Dr. Prout to be taken daily for about a month, or until lithic acid, or lithates, re-appeared in the urine. By adopting, said he, such a course of acids three or four times in the year, and by a carefully regulated diet, I have seen this diathesis gradually subdued, and at length removed altogether. Irritability of the bladder, in connection therewith, is not unfrequently subdued by the compound tincture of camphor; indeed, Dr. Bence Jones speaks of this remedy as having thus proved "very useful."

The association of oxalate of lime with uric acid in the urine, requires the anomalous administration of

both acids and alkalies. In such cases, supposing the deposit of oxalate to be considerable and persistent, Dr. Hassall suggests that it should be treated in the first instance. If the uric acid deposits be constant and in large quantity, alkalies and acids may sometimes be administered with advantage alternately.

Preventive Treatment will consist in the avoidance of those articles of food which are apt to produce or actually contain oxalic acid, and in the observance of the suitable diet. Conjointly, the precautionary use of the appropriate medicinal measures, occasionally.

Sulphuric acid—Treatment.—Animal and vegetable food having, apparently, equal influence in producing an excess of sulphates in the urine, no distinction can be drawn favourable to either kind of diet, as a remedial agent. But as sulphur is disengaged by the destructive metamorphosis of the nitrogenous tissues chiefly, and subsequently, by oxidation, converted into sulphuric acid, active exercise, which increases both these changes, is contra-indicated. Repose, and the requisite remedial measures for subduing febrile excitement, are, perhaps, the general indications to be fulfilled. Eliminative treatment would, of course, be curative, by removing the excess of sulphuric acid from the system; but the present state of knowledge in this respect is here, as with regard to other blood-conditions, too unsettled for practical purposes.

Preventive Treatment will consist in the anticipation

and avoidance of the causative conditions above alluded to.

Hippuric acid—Treatment.—This highly carbonaceous acid is produced in excess—either by vegetable food, itself too rich in carbon, or by medicine containing benzoic acid; perhaps also by the destructive metamorphosis of nitrogenous tissue, in secondary mal-assimilation; or by defective elimination of carbon through the liver, lungs, or skin. But little is known respecting remedial measures. The substitution of nitrogenous food, increased exercise, and the administration of medicines to increase the secretion of bile and sweat, would seem to be the most hopeful.

Preventive Treatment is guided by similar considerations.

Lactic acid—Treatment.—The pathological origin of this acid, in excess, is obscure. Food abounding with lactic acid,—introduced by primary assimilation, is undoubtedly one source. Of such kinds of food, are, milk and vegetables which have become sour, and sugar or amylaceous food which may be converted into lactic acid. But an excess would also seem to arise, in some cases, from the destructive metamorphosis of muscular tissue,—in secondary mal-assimilation; that tissue everywhere abounding with lactic acid. Mal-excretion through the skin is another alleged cause; the sweat, it is said, containing lactic acid. Hence the imputed pathological origin of

rheumatism. Defective respiration is also an apparent cause; lactic acid by oxidation, being readily converted into carbonic acid.

Taking these facts and opinions into consideration, the indications of Treatment are: to correct any error of diet, to moderate bodily exertion, to maintain or increase the functions of the skin by warm clothing; and to render the respiration more active, by daily exercise, when the excess of lactic acid rises apparently from an opposite condition, in this respect.

Preventive Treatment, as usual, consists in the anticipatory observance of the curative indications.

Chlorides—Treatment.—Introduced into the system by most articles of food—in the course of primary assimilation, and disengaged from the tissues, by destructive metamorphosis in secondary assimilation, an excess of chlorides in the blood and urine proceeds either from the food, or increased transformation of the textures. Vegetable food in general contains a much larger relative amount of the chlorides—of sodium and potassium, than animal food; and the component proportion of these salts in the various tissues of the body, is also different, and variable. Exercise of body and mind, — affecting chiefly the muscular and nervous systems, increases the chlorides in the urine. The remedial indications are obvious: an increased proportion of animal food, and rest.

Preventive Treatment is analogous, but anticipatory.

Sugar in Urine—Treatment.—This abnormal constituent of the urine may proceed, perhaps, from various sources; mal-assimilation—primary or secondary, but chiefly, from imperfect oxidation and destruction of the sugar-glucose produced in the liver, itself transformed glucogen, also produced in that organ. This, which is Bernard's theory, founded on experimental observations, is disputed by Dr. Pavy, whose observations led him to regard the transformation of glucogen ("hepatine") principally as a *post-mortem* change; but this again is denied by Dr. Harley, whose investigations may, therefore, be regarded as indirectly supporting the views of Bernard.

The imperfect oxidation of sugar is not apparently connected with deficient respiration.

Besides this natural origin of diabetes mellitus, there is also the accidental origin from injury to the medulla oblongata, and floor of the fourth ventricle, and to the sympathetic system of nerves.

Bearing in mind the pathological origin of this disease, the indications of treatment relate to diet rather than medicine. No known medicinal measures have hitherto proved essentially efficacious; but the disease can be controlled, and for an unlimited period, by an appropriate diet.

The rule to be observed is,—a scrupulous avoidance of every kind of food containing sugar, or which can

be converted into sugar. Rigorous abstinence is not equally imperative in every case, yet the indication is the same.

Animal food, therefore—including fish of all kinds, and eggs—is quite unobjectionable; while of vegetable food, the choice is restricted to greens, bran-bread or cake, and such articles as do not belong to the saccharine class of aliments. Of liquids—brandy-and-water, tea and coffee, are safe.

The diabetic bill of fare does not allow of much variety, and constant self-denial is required to keep within its bounds. Nevertheless, certain indulgences may be employed with impunity; and, so far as the personal experience of *one* diabetic patient in particular affords adequate information for the guidance of others, Mr. Camplin's observations* respecting himself are valuable and encouraging.

Genoa maccaroni proved to be one of the best substitutes for the bran-cake. Milk need not be forbidden. Cruciferous vegetables afford many agreeable varieties; cabbage, cauliflowers, broccoli, Brussels sprouts, &c.; sea-kale and spinach are quite harmless; onions are allowable, and in most cases turnips. Lettuces agreed when eaten sparingly with oil and vinegar. Tea is preferable to coffee, and with it milk may be taken freely, cream only in small quantity. Cocoa

* "Med.-Chir. Trans.," vol. xxxviii.

is allowable if prepared from the “nibs,” not that which is sold in cakes or powder. Pale French brandy should be taken, but only in measured quantities, say a tablespoonful with water. Wines are better excluded, excepting claret, which is a most suitable beverage.

Other hygienic means were very advantageous. Sponging with tepid water, followed by friction, proved highly beneficial; so also sponging with cold salt and water in summer, and an occasional warm bath in the winter. Warm clothing, a leather waistcoat, and gutta-percha soles to the boots in winter, appear equally important. Change of air and occupation were so favourable, that wheaten bread was substituted for the bran-cake during the period of relaxation.

A few words respecting medicinal treatment will suffice. Free perspiration affords some relief to the diuresis. Besides, therefore, the sudorific appliances just alluded to, the salts of ammonia are serviceable; the sesquicarbonate is an exception, at least it was so in Mr. Camplin's case. Citrate of ammonia, combined with citrate of iron, was useful. Bitters and alkalies proved very beneficial. Opiates are valuable in some cases as a temporary means of checking the secretion of urine, and allaying irritability of the bladder.

Preventive Treatment.—Such also are the preventive measures—dietetic chiefly, hygienic and medicinal subserviently—by the early and patient employment of which diabetes may be kept in subjection, and for

an unlimited period. By their instrumentality Mr. Camplin not only rescued himself from a deplorable state of health, but was preserved from the ever-threatening recurrence of this disease during a period of no less than fourteen years.

Cod-liver oil in large quantities, — seven or eight ounces daily,—is highly recommended by Dr. Bence Jones, in cases of considerable emaciation.*

Albumen in Urine—Treatment of Bright's disease.—The retention of urea and water, in the blood, with the discharge of albumen in the urine; and subsequently the proportionate exchange of water for albumen in this secretion, while the retention of urea in the blood proportionately increases: these are the changes in the relation of the blood and urine, which are essentially of therapeutic importance. Nutriment in its best form,—albumen,—is incessantly draining away from the blood; while effete and noxious matter,—urea,—representing the decay of the textures, is simultaneously retained: thus conceding the powers of life to the dominion of death. Besides the symptoms incident to this double process of destruction—by starvation and blood poisoning, both of which are faithfully represented by the condition of the urine—general dropsy supervenes, owing to the retention of the water, which infiltrates the cellular texture throughout the body,—presenting an additional symptom.

* "Stomach and Renal Diseases." 1850. Case p. 122.

Structural or pathologico-anatomical changes in the kidney are the immediate causes in operation;—congestion, followed by pale interstitial effusion, with desquamation and damage of the tubuli uriniferi; fatty, or waxy (amyloid) degeneration of the effused matter, or its absorption and contraction,—constituting the so-called granular degeneration, with irreparable destruction of the organ itself, which has become small and withered.

Remembering this abstract of the pathology of Bright's disease, the curative indications of treatment are,—to reverse, if possible, the relative conditions of the blood and urine, and thus restore the condition of health.

Cupping or blisters on the loins will tend to remove the renal congestion; but beyond thus aiming at the root of the disease, the perilous state of the kidneys forbids any direct attempt to restore their function. Subsequently, diuretics may be tolerated, and then prove serviceable. Digitalis, squills, or the tincture of cantharides,—cautiously administered, are, perhaps, the most efficacious. The pill originally prescribed by the late Dr. Baillie is an admirable formula. It consists of powdered digitalis, half a grain, and squills, one grain, combined with three grains of blue pill; to be taken two or three times a day.

Palliative treatment will have for its object the discharge of water, which has accumulated in the system,

by other channels than the kidneys ; *i.e.*, through the bowels and skin. Hence, hydragogue cathartics, *e.g.*, elaterium, croton oil, gamboge, jalap with cream of tartar ; and diaphoretics, *e.g.*, citrate of ammonia, the compound powdered ipecacuanha (Dover's powder), and hot-air or sweating baths ; are singly, conjointly, or in succession, often remarkably useful and comforting.

Irritability of the bladder ceases as the natural constitution of the urinary secretion is restored ; but the last-named medicine—Dover's powder—will also be conducive to this result, besides having a special action on the skin.

A generous diet, consisting of an increased proportion of albuminous food, as in the form of eggs, is especially necessary in the chronic disease, to replace the albumen which has been lost, and is still passing away ; with tonics also to support the circulation. The preparations of bark are thus effectual, but those of iron more so, for in no disease, perhaps, are the red corpuscles of the blood so reduced.

Further details respecting remedial treatment belong rather to special works on this disease.

Preventive Treatment has reference rather to the *causes* of that primary alteration of renal structure, whence the pathology of the blood and urine proceed. Those causes are preventible, in most instances. Scarlatina is an occasional cause—rarely, however, a pro-

ductive one, unless brought into operation by cold. After scarlatina has run its course, the residue of poison remaining in the blood appears to be naturally expelled by the kidneys, imposing extra functional duty on these organs; yet they generally fulfil their appointed task, unless when thus congested—bordering on inflammatory excitement—exposure of the body to *cold* should further impose an additional and intolerable burden. Then, under the pressure of *extreme* congestion, albumen is filtered off, urea retained, and fibrile dropsy supervenes. This *additional* strain on the excretory power of the kidneys, and its results, are obviously preventible. So also the more prevalent intemperate use of spirituous liquors imposes extra work on the kidneys; but even this strain may be made for years with impunity, although a hazardous experiment. Exposure to cold, however, becomes intolerable; it provokes albuminuria.

Such is the usual etiology of this disease, as originally investigated by Bright,* and which the experience of other observers has since confirmed. That “intemperance seems its most usual source, and exposure to cold the most common cause of its development.”†

* Reports of Medical Cases selected with a view of illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy. 1827, vol. i. p. 3.

† Guy's Hosp. Rep. 1836. Vol. I. Cases and Obs. illustrative of Renal Disease, accompanied with the secretion of Albuminous Urine, p. 339.

Bile in Urine—Treatment of Jaundice.—The retention of bile in the blood circulating, and thence its effect on the system at large,—of which the escape of biliary colouring matter in the urine is symptomatic—is the pathological condition of therapeutic importance. But this again has reference to the structural conditions of the liver or adjacent organs, by which such retention is effected. These causative conditions are ;—either mechanical, by obstruction in the ducts, or externally, to the free flow of bile into the duodenum, thus permitting the absorption of the bile imprisoned ; or, some structural disease of the liver,—arrest of secretion being then the immediate cause in operation, thus preventing the elimination of biliary constituents from the blood. Without any structural disease of the liver itself, arrest of its secretion may also be caused by various morbid states of the blood or of the nervous system, which, severally, paralyzing the function of this organ, induce jaundice.

The indications of treatment which may be gathered from the pathology of jaundice are of different practical significance, and hopefulness. If the retention of bile be due to some mechanical obstruction only, that causative condition may cease, spontaneously. An impacted gall-stone will most probably pass, in the course of time ; or the pressure externally, of any adjacent organ enlarged by disease, may itself be relieved, from time to time. Repeated opiates, or the warm bath,

will also tend to soothe and relax spasm, in the one case; and an accidental turn in the course of the disease, may bring relief in the other. But with structural disease of the liver itself, remedial measures become necessary, yet the result is less hopeful. An appeal to the secretory power of the liver may have a satisfactory response, and thus the administration of the cholagogue purgatives, large doses of blue pill or taraxacum, with salines to unload the portal circulation, may be advisable. Arrest of secretion by the influence of various blood-poisons, or powerful mental emotions, or the shock of bodily injury, affecting the nervous system, are cases scarcely within the reach of medicine. Thus, jaundice arising, occasionally, from pyæmic infection of the blood, from poisoned wounds, and from various fevers, subsides only as the morbid matters in operation are eliminated through other channels of excretion.

Preventive Treatment.—The appropriate preventive measures with regard to each of the blood diseases—the causes and treatment of which we have now considered, are at once suggested by reference to the causes themselves.

Temperature is the main question to be considered in reference to the prevention of *jaundice*. Not that other etiological conditions are unimportant, but they are for the most part beyond our control.

A hot climate *predisposes* to jaundice by enfeebling

the circulation and inducing congestion of the liver. It is probable also that diminished oxygenation of the blood, through habitually breathing a hot atmosphere, aids this effect on Europeans, prior to their acclimatization. Hydro-carbonaceous matter, ordinarily eliminated by the lungs, accumulates in the blood, and the liver is proportionately overtaxed—a burden increased by indulging in stimulating liquors, especially malt beverages, which, abounding with hydrocarbonaceous matter, fall heavily on this organ, and further tax its functional power beyond endurance.

Such being the predisposing influences of high temperature, any change of temperature approaching to cold is the *immediate* or exciting cause of jaundice. In *every* case, Sir Ranald Martin affirms,* that he has seen in England amongst those who have returned from India, cold has been the immediate cause of this disease. Taking seventy-two cases of icterus typhoides, by Lebert, one-third occurred in November and December.

The preventive measures suggested by these observations are plain. They are most important to persons about to visit any tropical climate. Although unavoidably subject to the physiological influences of heat, certain precautions are available. Prudent moderation in the use of stimulating beverages, and the

* "Influence of Tropical Climates in producing the Acute Endemic Diseases of Europeans," ed. 2, 1861.

careful regulation of clothing, should be rigidly observed. Besides adequate protection against the vicissitudes of external temperature, the cautious indulgence of cold drinks—iced beverages—is an injunction not to be forgotten. On returning home, after residing for some time in a tropical climate, it is advisable, if possible, to pass the ensuing winter in a more even climate than that of England. And when residing again in this country, the continued observance of these precautions, especially as regards vicissitudes of temperature, will prove the most efficacious preventive measures.

URINARY CALCULI.

Urinary calculus, or stone, signifies a concretion of one or more of the constituents of the urine, forming a hard mass.

Origin.—Any such concretion originates from the precipitation of the component urinary constituents, as urinary deposits, in consequence of a loss of solvent capacity in the water of the urine. But this disturbance of solvent capacity may arise in either of three ways: (*a*) by an excess of any substance for the water to dissolve; (*b*) by a deficiency of water as the solvent; or (*c*), by the presence or absence of some third substance. Thus, then, different analyses of the urine occur in some part of the renal appa-

ratus—kidneys or bladder—precipitating urinary deposits.

Production of Calculus.—The formation of a calculus may occur in either of two ways: (1) The deposit may aggregate from a focus of its own substance; (2) or around a foreign body, as a distinct *nucleus*, the more frequent mode; in either way forming a calculus.

In the former mode of production, aggregation depends on (a) an excess of insoluble constituents, and thence their *immediate* precipitation, *e.g.*, in the forms of uric acid, urate, and oxalate concretions; or (b), stagnation of urine in the bladder, in connection with paralysis, chronic cystitis, and hypertrophy of the organ, enlargement of the prostate, or stricture of the urethra, as causative conditions of retention of urine, *e.g.*, in the formation of phosphatic calculi.

The *nucleus*, when distinct, is some foreign body; a small clot of blood, or mucus, derived from the urinary organs in which the calculus originated; or it may be some extraneous foreign body, introduced into the bladder through the urethra, or by wound or ulceration of the organ.

The *constituents* of a calculus are fixed, in the state of aggregation, by some kind of *cement*, apparently animal matter—mucus, fibrin, or fatty matter; possibly blood, epithelium, or even pus.

The *seat* of origin, in the urinary organs, has already been adverted to; commonly the kidney or

bladder, occasionally, however, in the urethra, as the dilatation behind a stricture; thus a calculus is designated *renal* or *vesical*, possibly *urethral*. Generally, a urinary calculus originates in the kidney, and subsequently descends, as a small stone, into the bladder, where it increases by further concretion.

Urinary calculus differs in its physical characters and chemical composition, thus representing different classes and species of urinary calculi.

Physical characters comprise colour, shape, size, weight, consistence, and section-appearance (also number). These characters, and their differential peculiarities in the various species of calculi, are indicated conveniently in Table (I).

Section of a calculus presents a certain *structure*; a distinct nucleus, in most species, and the surrounding concretion, which has an external crust, more or less distinct. The concretion-substance is commonly disposed in concentric layers or laminae, and sometimes shows radiating lines from the centre to the circumference of the stone; or it may be continuous, having no visible arrangement. The former appearance corresponds, apparently, to successively active periods of urinary deposit, as depending on varying states of the urine; while the latter appearance would indicate the result of an uninterrupted deposit.

(I.) TABLE INDICATING THE PHYSICAL CHARACTERS OF URINARY CALCULI.

Arranged in the Order of their Chemical Affinity with regard to Tests. (See TABLE II.)

	COLOUR.	SHAPE.	SIZE.	WEIGHT.	CONSISTENCE.	SECTION.
Uric or lithic acid.	Brown, light, or dark.	Ovoid and flattened.	Pea to orange.	Heavy.	Hard; fractured into sharp angular fragments, and crystalline.	Concentric laminae radiating lines from nucleus.
Urate of ammonia.	Clay or slate, or reddish brown.	Ovoid, smooth, or tuberculated.	Small.	—	Fracture earthy (not crystalline).	Homogeneous.
Uric or xanthic oxide; very rare.	Cinnamon.	Flattened.	Small, as pullet's egg.	—	Hard; fracture not crystalline.	Laminated.
Cystic oxide or cystine; rare.	Yellowish brown; grey-green or slate after long exposure; and waxy, glistening, slightly transparent.	Round, smooth, or tuberculated.	Small.	—	Soft and pulverescent; fracture crystalline; powder is white.	Homogeneous, with imperfect radiation.
Fibrinous calculus; rare.	Yellow.	Pea-shaped.	—	—	Fracture vitreous and lustrous; like yellow wax.	
Uro-stealith; very rare.	Resinous or fatty bodies.	—	Small.	—		
Blood-calculus; very rare.	Disintegrated blood-corpuscles, with phosphate of lime; black colour.	—	From coriander-seed to horse-bean.	—	Friable; fracture amorphous.	Amorphous; dull, rusty.

Carbonate of lime; very rare.	White or ash.	Spherical or irregular.	Pea to nut, or larger.	—	Soft and friable, or very hard; fracture amor- phous.	No concentric la- minae, or imper- fectly lamellar.
Oxalate of lime, or mulberry calculus.	Dark brown blackish green.	Spheroidal, tuberculated, angular, or spinous; rarely smooth.	Marble to horse- chestnut.	Very heavy.	Very hard; frac- ture crystalline.	Imperfectly lami- nated in irregu- lar waved lines.
Varieties; rare.						
Hemp-seed calcu- lus.	White-brown.					
Crystalline.	Pure white.					
Ditto.	White or grey.	Irregular; somewhat spiculated.	Large probably.	—	Friable fracture, perhaps crystal- line.	Imperfectly lami- nated.
Phosphate of am- monia and mag- nesia.—Triple phosphate.						
Phosphate of lime; renal origin.	Pale brown.	Spheroidal and smooth.	Small.	—	Friable.	Laminated.
Vesical origin; bone- earth phosphate.	—	Irregular masses, or granular semi-crystal- line powder in tena- cious mucus.				
Phosphate of mag- nesia and ammo- nia, with phos- phate of lime.— Mixed phosphates. Fusible calculus.	White grey or dull yellow.	Very irregular; moulded to locality; sometimes globular or ovoid; or in pieces, cubic or tetra- hedral.	Large probably.	—	Very friable or pulverescient, or soft, like moist chalk.	Concentric lami- nae, or semi- crystalline, ac- cording to pro- portion of the phosphates.
Silicious calculus, only in other cal- culi.						

Simple calculus consists of only one chemical constituent, and thus presents a section uniform in colour and consistence; *compound* calculus consists of different constituents, presenting a section of varying appearance at different depths. Lamination may occur in the formation of both a simple and a compound calculus. In the latter, the successive deposition of different matter may have a regular alternation, forming an *alternating* calculus.

The *nucleus* varies, as already said, in its nature, and also in its situation, number, and connection with the surrounding concretion. Thus, commonly central, or nearly so, it may be very eccentric, as in some renal calculi; usually single, there may be two or several nuclei, as distinct centres of concentric deposition; and usually connected and fixed, the nucleus may be isolated and loose, owing apparently to a layer of blood or mucus having first gathered around it, followed by the concretion, while the organic matter has dried and disintegrated, isolating the nucleus. Lastly, the latter may itself have disappeared, leaving a central cavity; this result ensuing, probably, when the nucleus was organic matter which has undergone disintegration.

Chemical Composition.—Urinary calculi, in regard to their essential constituents, may be divided into two classes, a third class representing the more rare forms: (1) calculi consisting of uric acid and urate of ammonia,

with their varieties, the oxalate of lime, uric or xanthic oxide, and cystic oxide or cystine; (2) phosphatic calculi in all their varieties, as phosphate of ammonia and magnesia, or triple phosphate, phosphate of lime, and mixed phosphates of lime, magnesia, and ammonia, or the fusible calculus; (3) the fibrinous uro-stealith, carbonate of lime, and silicious calculi.

The *relative frequency* of different calculi varies in different countries. Thus, comparing India and England:—(1). In Bombay, the proportion of oxalate of lime calculus is about twice that in England, taking standard collections of calculi, for comparison, in both countries. (2). The proportion of uric acid calculi is considerably less in India than in England; in the former country, urate of ammonia calculi are somewhat more frequent than uric acid calculi, and conversely in England. (3). The proportion of phosphatic calculi is much less in India than in England, owing to the rarity of the mixed phosphates in the former country. In making these estimates, the calculi compared relate to the composition of the nucleus, or the entire substance of the concretions.

Examination of Urinary Calculi.—The *appliances* requisite for the examination of calculi are few and simple: a platinum spoon or piece of platinum foil, a spirit-lamp, and sometimes the aid of a blow-pipe; test-tubes and watch-glasses, with the acids—nitric and hydrochloric, and the alkalies—carbonate of potash and

oxalate of ammonia. Certain special reagents will be noticed in the table.

The *order of procedure* is, first to test a bit of the calculus in powder, by *heat*, and thus refer it to one of the two divisions—calculi combustible and destroyed by heat, leaving only a very little residue; or, calculi non-combustible, and not destroyed by heat, leaving a considerable residue. In the former case, the original powder is to be tested for uric acid, urate of ammonia, uric oxide, or cystic oxide; in the latter case, it is to be tested for (carbonate of lime) oxalate of lime, ammoniaco-magnesian, or triple, phosphate, phosphate of lime, or mixed phosphates. Next, the *mineral acid* test is to be applied: if a combustible calculus, dilute nitric acid should be used; if a non-combustible calculus, dilute hydrochloric acid is preferable. Then, the *alkaline* test must be applied. Lastly, the *special tests* may be resorted to.

The relations of calculi to *tests*, general and special, are conveniently shown in the following tabular view, which represents also the order of chemical examination. It is enlarged from the well-known Lectures of Dr. Bence Jones on Animal Chemistry:—

(II.) TABLE FOR EXAMINING URINARY CALCULI.

1. By HEAT.	2. By ACIDS.	3. By ALKALIES.	NATURE OF THE CALCULUS.	SPECIAL TESTS.
Destroyed by heat.	With nitric acid, red.	Soluble in carbonate of potash, evolving <i>no</i> ammonia.	Uric acid.	Solution in caustic ammonia or potash, on the addition of an excess of acid, crystallizes in angular crystals. Not soluble in water.
Not destroyed by heat.	With hydrochloric acid soluble; <i>before</i> heating effervesces.	Soluble in carbonate of potash, evolving ammonia.	Urate of ammonia.	Soluble in water, when boiled. Solution in water, with a few drops of ammonia, evaporated, crystallizes in needles—microscopic.
(Not destroyed by heat.)	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in ammonia, <i>not</i> crystallizing when evaporated.	Uric or xanthic oxide.	Insoluble in carbonate of potash, dissolves without effervescing in nitric acid, leaving a lemon-coloured residue; soluble in strong sulphuric acid, not precipitated by dilution.
Not acted on	With nitric acid, not red.	Soluble in ammonia, crystallizing when evaporated.	Cystic oxide or cystine.	Soluble in strong caustic potash; the solution, boiled for a few moments, on the addition of a drop of dilute acetate of lead, gives sulphuret of lead.
Not acted on	With hydrochloric acid soluble; <i>before</i> heating effervesces.	Soluble in ammonia with difficulty, not crystallizing.	Fibrin.	With nitric acid becomes directly yellow. Solution in caustic potash precipitable by acetic acid in amorphous form.
Not acted on	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.	Carbonate of lime.	Soluble in dilute acetic acid, with effervescence.
(Not destroyed by heat.)	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, with excess of ammonia, gives a crystalline precipitate.	Oxalate of lime.	Insoluble in acetic acid. Boiled with carbonate of soda, oxalate of soda is dissolved, precipitated by chloride of calcium.
Not acted on	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, with excess of ammonia, gives an amorphous precipitate.	Phosphate of ammonia and magnesia.	With half its bulk of phosphate of lime (bone-earth), is very fusible before the blow-pipe.
Not acted on	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, with excess of ammonia, gives an amorphous precipitate.	Phosphate of lime.	With twice its bulk of phosphate of ammonia and magnesia is very fusible before the blow-pipe.
Not acted on	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Mixed phosphates.	Without addition, easily fusible before the blow-pipe.
Not acted on	With hydrochloric acid soluble; <i>after</i> heating effervesces.	Soluble in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Silica.	Fused with twice its bulk of carbonate of soda, forms glass; soluble in water, precipitable by hydrochloric acid.

Causes of Urinary Calculi.—The urinary *production* or formation of calculus has already been noticed. *Predisposing* causes are here considered.

Climate and *locality* have apparently some predisposing influence. Calculus is more common in temperate than in warm and cold regions, and more especially in humid countries of moderate and changeable temperature, such as Holland, France, Germany, and England. It occurs, however, very frequently in Egypt, Isle of France, Russia, Bagdad, and both the East and West Indies. Some parts of the same country are certainly more prone to calculus production than other parts; as particularly the county of Norfolk in this country. *Race*, it is said, has different proclivities; that calculus disorders are more common among white than dark races of men, yet stone is of very frequent occurrence among the natives of India.

Hereditary transmission is evinced in the gouty diathesis, and the production of lithic acid calculi.

Sex undoubtedly affects the relative proportion; stone is less frequent in females than males, in the proportion of 1 to 20, or 1 to 23. This remarkable disproportion is attributed mainly to the peculiar anatomical disposition of the female urethra; its comparative shortness, larger size, dilatibility, and straight course, all these circumstances facilitating the passage of a small stone.

Period of Life or Age.—Stone may occur at any

age; and, according to Stahl and Geyer, it occasionally exists as an intra-uterine affection. But the two extremes of life seem to be most subject; stone being met with most frequently, it is said, in young and in old people. Of 5,376 cases collected by Civiale: 1,946 occurred before the age of 10 years, 943 from 10 to 20, 460 from 20 to 30, 330 from 30 to 40, 391 from 40 to 50, 513 from 50 to 60, 577 from 60 to 70, 199 from 70 to 80, and 17 after 80 years of age. Coulson has collected 3,264 cases of lithotomy: under 20 years of age, the proportion was 71·20 per cent.; between 21 and 40 years, 12·10 per cent.; between 41 and 60, 10·87 per cent.; and between 61 and 80, 5·72 per cent. Sir H. Thompson's table comprises 1,827 cases: under 20 years of age, 60·42 per cent.; between 21 and 40, 10·18 per cent.; between 41 and 60, 17·56 per cent.; and between 61 and 81, 11·83 per cent. Respecting the value of these statistics, Mr. Coulson has well remarked, that they represent the absolute number of persons affected with stone at different ages; but not as relative to the total number of persons living at the several periods of life. Thus, if all persons under 20 years were affected with a certain disease, and all persons over 70 years were affected with the same disease, the liability would be the same, although the absolute number of persons attacked would be very different. By correcting this error between absolute and relative numbers, the tables

would show that children and young persons are less liable to calculous disorders than is commonly supposed; that from 20 years upwards, the tendency goes on increasing in a very remarkable manner to the end of life. Sir H. Thompson thus expresses it: "That the proportion of elderly calculous patients to the existing population at their own ages is larger than the proportion of children affected is to the number of existing children."

Habits of life have unquestionably some causative tendency. Thus, sedentary habits diminish the perspiratory secretion, and throw increased work on the kidneys; high living, and especially indulgence in various kinds of nitrogenized food, and certain beverages, supply the material for uric acid and other allied concretions, while indigestion and secondary mal-assimilation in the textures generate uric acid.

Various morbid conditions of the *urinary organs* may induce calculous formations; the presence of a foreign body especially, which solicits the precipitation and deposition of the urinary constituents around itself as a nucleus.

Other accredited causes are doubtful. Thus, the imputed influence of certain mineral waters is fallacious, none of the forms of calculi corresponding to the salts in such waters. The alleged exemption of persons in certain occupations, as soldiers and sailors, seems very doubtful.

Diagnosis of Urinary Calculi.—In relation to treat-

ment—whether medical or surgical, and especially the former, the *species* of urinary calculus is a question of great importance.

The elements which, singly or collectively, determine the diagnosis are,—examination of gravel or small portions of concretion passed in the urine, the accompanying condition of urine, the constitutional condition or diathesis, and the other predisposing causes already enumerated. If all this knowledge should fail to establish any positive conclusion as to the nature of a calculus, it may at least have a *negative* value, by indicating the species to which the stone is not allied, and thus indirectly guide to an appropriate treatment.

Examination of *gravel* or small portions of concretion, supplies the most exact knowledge relative to the species of calculus co-existing.

The condition of *urine* passed at the same period affords the next most reliable ground of diagnosis. Urinary reaction and deposits are here the indications to be observed.

The *reaction* may be acid or alkaline; and the latter from fixed alkali, or from volatile alkali—carbonate of ammonia.

(1.) *Acid* reaction will indicate that the calculus is either uric acid or oxalate of lime, or a combination of both species of concretion. A *deposit* of one or other of these constituents can alone determine the

particular species of calculus. Not unfrequently, either deposit alternates with the other, and then a combination of both may be inferred. The presence of either deposit in the urine for any considerable period would indicate that the external crust of the stone is of that kind; but this will fail to indicate the composition of the deeper substance.

Renal calculi contrast with vesical calculi, in being much more simple — consisting usually of only one species, while the vesical are usually compound,—consisting of two or more species. This complexity increases often according to the period during which the calculus has remained in the bladder. Consequently, if the calculus originated in the kidney, but has descended into the bladder at a recent date, it will probably be *simple*; and while an acid reaction might indicate either uric acid or oxalate of lime, the deposit will probably determine which species constitutes, in this case, the *entire* calculus.

The relatively greater *frequency* of uric acid compared with oxalate of lime calculus, is a consideration which will aid and corroborate an otherwise doubtful diagnosis; but such evidence is of much less value than that supplied by examination of the urine.

Constitutional predisposition is a more important element in our calculation of probability. Thus the gouty diathesis will more probably be associated with uric acid than with oxalate of lime calculus.

(2.) *Alkaline* urine has a widely different significance, according to the nature of the alkali. *Fixed* alkali is associated with phosphate of lime, or with carbonate of lime. Both these species of calculi are rare, and the latter extremely so. *Volatile* alkali-carbonate of ammonia is always associated with a calculus—when present—the crust, at least, of which consists of phosphate of ammonia and magnesia, with phosphate of lime, forming the mixed phosphates or fusible calculus. But the composition of the nucleus and body of the calculus is not indicated. And the thickness of the crust will depend on the greater or less degree of ammoniacal reaction and odour; and this, again, will be influenced by the quantity of mucopurulent secretion, as estimated by its discharge in the urine; and the duration of this twofold condition of urine will, of course, affect the resulting proportion of the encrusting deposit. At length, even portions of phosphatic concretion may be passed with the urine. It is necessary to observe that the urine is ammoniacal when passed, and not as the result of decomposition, subsequently.

RENAL CALCULUS.

A stone forming in the pelvis of the kidney may, or may not, be attended with pain or other symptoms of nephritic irritation. Frequently, it remains

quiescent and unsuspected when lodged in this dilated portion of the ureter. It may there attain a large size and remarkably irregular shape, being moulded to the pelvis and calices of the ureter within the hilus of the kidney. Absorption of the kidney-substance results from the continued pressure, and this is attended with pain in the lumbar region and symptoms of nephritis. In rare cases, abscess has been known to ensue, and the stone discharged through an aperture in the loin.

A *small* stone in the pelvis of the kidney usually descends through the ureter into the bladder; it gradually increases in size, as a vesical calculus, by accumulating concretion on its surface.

The *descent* or passage of a renal calculus is accompanied with more or less severe pain and constitutional disturbance, in proportion to the size and shape of the stone. A small, smooth stone may descend without occasioning any notable suffering. A larger-sized and rough stone, as a mulberry calculus, descends with much difficulty, and causes proportionate agony. After, perhaps, some symptoms of nephritic irritation, the patient is seized with sudden and excruciating pain in the loin, extending down the course of the spermatic cord to the testicle, which is often retracted, and down the thighs. This agony may, as it is said, "double the patient up," and make him roll on the ground, vainly seeking and imploring relief. It is

worse to bear, and to witness, than the pain in passing a gall-stone. Bloody-urine, vesical irritability and frequent micturition, with vomiting and constitutional irritation, are the additional symptoms of a descending renal calculus, and which simulate acute nephritis. But the constitutional disturbance is not febrile, the pulse remaining comparatively unaffected. These symptoms continue, with occasional remissions, from generally twelve to twenty-four hours—the usual period occupied by the descent of a renal calculus; when, on its entering the bladder, all the symptoms suddenly cease. This origin, course and character, and termination of the symptoms determine the diagnosis. Sometimes, the calculus remains impacted in the ureter, and symptoms of calculus pyelitis supervene. When the stone has become vesical, and is lodged in the bladder, the symptoms of stone in the bladder ensue.

Treatment.—Only palliative measures are available. Opium is the most efficacious anodyne for assuaging the nephralgic pain, and the patient can be kept under its influence during the whole period of passing the stone. Chloroform may, however, be administered with advantage, from time to time, as a relaxant. The warm bath is also a most serviceable adjunct. Cupping to the loins, followed by warm fomentations, may afford some relief. The bowels should be thoroughly emptied by mild oleaginous enemata, and diluent drinks freely allowed.

TREATMENT OF CALCULI.

Urinary calculi may be subjected to two kinds of treatment—medical and surgical.

Medical treatment has two objects in view: the *prevention* of the formation of a calculus, when the causative conditions predisposing thereto exist; the *removal* of a calculus, by solution, and the expulsion of its constituents through the urethra—the solvent treatment.

Surgical treatment is restricted to the accomplishment of the latter object—the removal of a calculus, and by means of certain operative and mechanical procedures: *lithotrity*, the removal of a stone mechanically, by crushing it in the bladder with instruments, and extraction or expulsion piecemeal of the *débris* through the urethra, or perhaps by simple dilatation of the urethra without any cutting operation; *lithotomy*, or the extraction of stone by a cutting operation.

The two kinds of treatment are here stated in the order of their relative desirability, but their practicality is nearly the reverse, surgical treatment being generally far more effectually curative. Still, however, to complete this work I shall here notice the medical

treatment of calculi, especially from a preventive point of view ; operative procedures are fully described in my work on Surgery, recently published.

Preventive Treatment. — The prevention of calculous concretion presupposes the recognition of any such signs as may indicate a predisposition thereto, and in due time to anticipate this result. An habitual and persistent *deposit* in the urine of some one or more of the constituents of a calculus, is the surest indication of the probable issue. Thus, persistent deposits of uric acid, urates, oxalate of lime, earthy phosphates, or cystine, as the constituents, severally, of the more common species of urinary calculi, are premonitory of their formation ; but only under, or particularly, certain circumstances of urinary deposit. The significant conditions are, when the deposit, as of uric acid or oxalate of lime, is found in the urine, immediately after micturition, or is deposited before it has cooled. Either appearance would indicate that the constituent of one or the other concretion is secreted with the urine. Whereas, the same appearance taking place at a subsequent period, when the urine has stood for a few hours, might be the result of after-changes. An ammoniacal condition of urine, in connection with cystitis, has always a tendency to concretion of the earthy phosphates deposited. The liability to calculous formation will be obvious whenever any portion of concretion has passed with the urine, or the patient

has undergone an operation—lithotrity or lithotomy, for the removal of stone from the bladder.

Preventive treatment may be general, as relating to all calculi, or special, as relating to the different species of stone. The *general* indications are to prevent any concentration of urine, and its prolonged retention in the bladder. Either, or both conditions would obviously have a direct causative tendency to the formation of calculous concretion. Concentration of the urine occurs mostly after fasting, some hours previous to the next meal, and during sleep; in the latter physiological state of the system also, the urine is not only scanty, but retained in the bladder for a longer period than in the day-time. And during fasting or sleep—states of the system more or less remote from the process of digestion—the urine becomes highly acid; but again more nearly alkaline after a meal, when a flow of the acid gastric juice into the stomach, reduces the acidity of the blood. The recumbent posture, during sleep, was conceived by Dr. Prout, to favour the accumulation of urine in the pelvis of the kidney, and thus possibly induce the formation of renal calculus.

To meet all these contingencies, an increased quantity of water or other aqueous fluid should be drank, especially after an interval since food was taken, or at bed-time. The intervals between meals, moreover, should not be protracted, nor sleep in bed unnecessarily prolonged. Thus, a tumbler of water may be taken

once or twice daily; particularly before a late dinner, and on going to bed; while, instead, perhaps, of only two meals a-day—breakfast and dinner—luncheon should also be taken, at nearly equal intervals, and early rising should be enjoined. The latter precaution will be of less consequence if the individual be accustomed to wake once or twice in the night, when the bladder can be relieved of its contents.

Special preventive measures.—Predisposition to the formation of *uric acid* calculus may be controlled by the medicinal and dietetic measures already noticed in relation to the precipitation of this acid as a urinary deposit. Alkalies, such as the bicarbonate, acetate, or citrate of potash, in drachm doses to a tumbler of water, as a diluent, should be taken morning and evening. Vichy water or lithia water may be drank in preference. A reduced proportion of animal or azotised food and more active exercise to carry off any excess, will also have a preventive tendency. Free perspiration, to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Hence warm clothing, warm bathing, friction of the skin by the daily morning use of Turkish towels, or horse-hair gloves and belt, are most efficacious.

Predisposition to *oxalate of lime* concretion may probably be kept in subjection by the observance of similar precautions. Aqueous drinks to prevent any

supersaturated solution of the oxalate; and the avoidance of those articles of diet which contain, or perhaps generate, oxalic acid, — as rhubarb, sorrel, onions, tomato, and sugar, or sugar-forming food. Animal food, with brandy and water instead of beer or wine, form a suitable diet; but no hard water should be drank—it should be distilled, to deprive it of lime. Otherwise, the lime combining with oxalic acid would induce the urinary concretion. Medicinal preventive measures may be either acids or alkalies. The mineral acids, particularly hydrochloric and nitro-muriatic acids, were strongly recommended by Dr. Prout. On the other hand, alkalies might prove serviceable, if uric acid by conversion be the source of the oxalic acid. Both acids and alkalies may be administered alternately, to combat any tendency to an association of the two species of calculous concretion.

The prevention of *phosphatic* concretions relates especially to the *earthy* phosphates,—the more common constituents of such calculi. The phosphates of lime and magnesia are deposited, in connection with an ammoniacal alkaline state of the urine, as depending on muco-purulent cystitis. Concretion is apt to form around some portion of pus or mucus, or a fragment of any stone left in the bladder after lithotrity or lithotomy. Hence the corrective use of acids is indicated, and particularly by injection into the bladder, as in the treatment of chronic cystitis.

No special preventive treatment is required for *cystine* concretion, which is comparatively rare, and any tendency to which will be counteracted by the measures appropriate for uric acid calculus.

Solvent Treatment.—The removal of a calculus by *solution* is a mode of *cure*, which has been attempted by either of two kinds of agents: by chemical solvent agents,—lithontriptics administered by the mouth, or by injection into the bladder; by electrolysis,—the transmission of an electric or galvanic current, for the dissolution of stone in the bladder.

(a) *Chemical* solvent agents comprise alkalies and acids. The former class of remedies may be employed for the removal of calculi, which are soluble in alkalies, *i.e.*, uric acid, urates, and *cystine*; the latter class, for those calculi which are soluble in acids, *i.e.*, oxalate of lime and phosphatic concretions. The mode of administration of either class of these remedies might be, by the mouth, or by injection into the bladder. *Practically*, however, the chemical solubility of urinary calculi, and the mode of attacking them, seems to amount to this: that uric acid calculi only, and allied concretions, are soluble by alkalies, and as administered by the mouth; phosphatic calculi only by acids, and by injection of the acid solution. Oxalate of lime calculi cannot be dissolved by any known solvent agent or method of administration.

It would appear also, from Dr. W. Roberts's ori-

ginal series of experiments and clinical observations, that *renal* calculi are more generally amenable to solvent treatment, than vesical calculi; of course, necessarily, by the internal method, or passage of the remedy through the kidneys.

The *internal method* is applicable for the solution of *vesical* calculi, according to the observations referred to, only in cases of uric acid calculus, where the stone is not large, and the urine is acid.

Certain rules should be observed in applying this solvent treatment: to keep the urine *continuously* alkaline, and to maintain this state to a certain *degree*. A solution of bicarbonate of potash, less in strength than three grains to the pint of water, will have scarcely any greater effect than simple water.

The acetate and citrate of potash are the best salts for administration. Of the former, the dose for an adult should be from forty to sixty grains, in three or four ounces of water; for children, from twenty to thirty grains. The citrate is best prepared pure and of uniform strength from the crystallized bicarbonate of potash by the crystallized citric acid. Thus, the following prescription, recommended by Dr. Roberts, yields a solution containing one drachm of the citrate in each fluid ounce:—

R Potass. Bicarb., ʒxij.
Acid Citric, ʒviij., gr. xxiv.
Aquæ ad ʒxij.

The dose for an adult is six to eight drachms, mixed with three or four ounces of water; for children, three to six drachms, diluted in the same proportion.

To fulfil both the rules laid down, the dose must be repeated at intervals of not less than every three hours during the day, taking a dose the last thing before going to bed, and another, if the patient should be awake, in the night.

In conducting the treatment, the freshly voided urine should be frequently examined. If, at any time, it becomes ammoniacal, as denoted by the odour and muco-purulent deposit, the solvent treatment must be suspended. So long as the urine remains free from ammoniacal taint, when passed, there will be no risk of any deposition of the mixed phosphates encrusting the stone.

Injection.—The other method of applying solvent agents is restricted chiefly to calculi which are soluble in acids—phosphatic calculi. Alkalies, administered by injection, have very little effect on uric acid calculi; and acids pass through the kidneys only in very small proportions.

The injection method of treatment is, however, somewhat in this dilemma, that the solution, if strong enough to have any useful effect, may endanger the coats of the bladder; and if sufficiently diluted to avoid this danger, any solvent action on the stone is very uncertain.

A weak solution of nitric acid—two, or two and a half minims of the strong acid to the ounce of distilled water—was used by Sir B. Brodie, for the solution of phosphatic calculi by injection; and with the result of greatly reducing the size of the stone, or even at length accomplishing its entire dissolution. A weak solution of acetate of lead—one grain to the ounce, with a mere trace of free acid, was the preparation and strength employed by Dr. Hoskins.

After lithotrity, injection may be used, as a solvent method of treatment, adjunctive to, or as a substitute for, the repeated operations of crushing fragments. The comparative merits of these two modes of procedure—the chemical solution, or mechanical crushing of stone in the bladder—must be determined by their relative speed and safety in effecting a cure. Good results have been obtained. Notably in a case by Mr. Southam, of Manchester. After repeated lithotrity, fresh phosphatic concretions continued to form in the bladder as fast as the old ones were crushed, so that the bladder could not be cleared. The mechanical operation having thus failed, an injection, containing two drachms of dilute nitric acid to a pint of water, was resorted to every day, or every second day. In the course of a short time, the old fragments were entirely dissolved, and the formation of new concretions prevented.

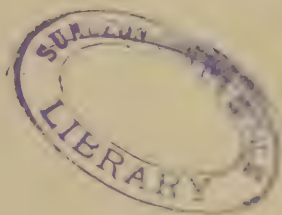
Injection may be performed through a double-cur-

rent catheter, whereby a continuous stream of the solvent is made to act upon the stone.

(*b*) *Electrolysis*, or the dissolution of stone in the bladder by the transmission of an electric or galvanic current, has had its advocates. Sir W. B. O'Shaughnessy, Dr. Bence Jones, Dr. L. Melicher, and Gruithuisen, have severally attempted this method of treatment.

It will be seen that the foregoing methods of treating urinary calculi apply only to exceptional cases.

The established surgical operations of lithotritry and lithotomy are fully considered in my work on the "Science and Practice of Surgery."



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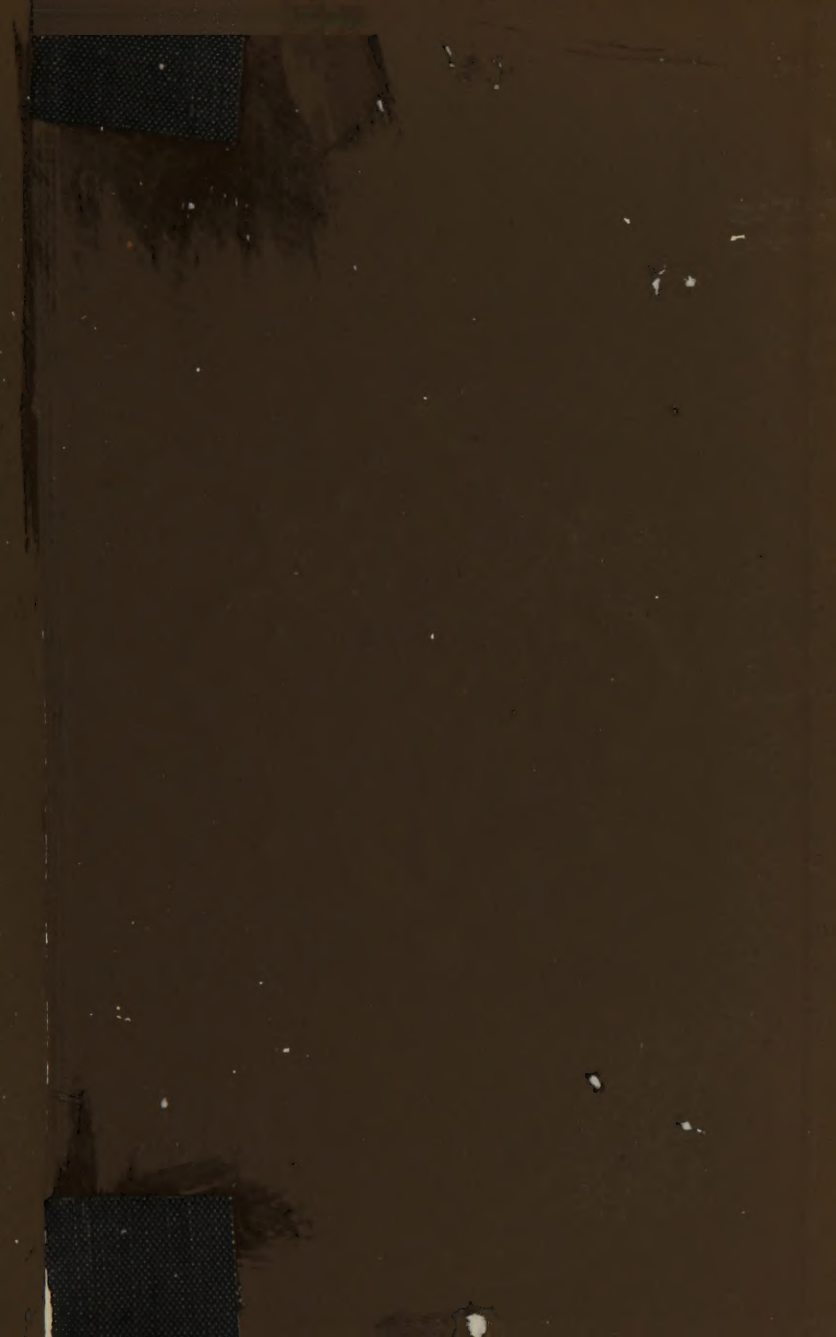
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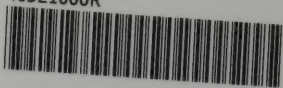
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